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The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: The Pseudozygopleurinae

By J. Brookes Knight

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THE GASTROPODS OF THE ST. LOUIS, MISSOURI, PENNSYLVANIAN OUTLIER: THE PSEUDOZYGOPLEURINAE

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ABSTRACT

"Explosive evolution" has considerable interest for stratigraphic paleontologists, taxonomists and geneticists. Those Pennsylvanian gastropods which may be called loxonematoid seem to show such explosive evolution to a remarkable degree. Many of them are small enough to escape destruction by the drill bit and hence may eventually prove to be of value for subsurface correlations. The most abundant of these simulate as adults the form of *Zygopleura* Koken and of late years have been referred to that genus by common consent. It is shown, however, that their early ontogeny is fundamentally different from that of *Zygopleura*, and accordingly that they are not properly referred to that genus of which they are merely homeomorphs. The early ontogenetic history of the Pennsylvanian zygopleuroids is recorded in a very distinctively sculptured nucleus. This same nucleus points to a similar ontogeny in many other forms some of which as adults depart widely in form and ornamentation from the zygopleuroids. Just as different ontogenies are held to separate the Pennsylvanian zygopleuroids from homeomorphic Triassic *Zygopleura*, so identical early ontogenies are held to unite phyletically (and therefore taxonomically) forms that may be very different as adults. The genera *Pseudozygopleura*, *Helminthozyga* and *Cyclozyga* are proposed and defined and the genus *Hemizyga* Girty is redefined. The sub-genera *Pyrgozyga*, *Leptozyga* and *Stephanozyga* which with the typical subgenus compose the *Pseudozygopleurae* and the sub-genera *Plocezyga* and *Hyphantozyga* which with the typical subgenus make up the *Hemizygae* are proposed and defined. The whole are united in the new sub-family Pseudozygopleurinae, here defined, and referred to the Loxonematidae Koken. The evolutionary trends within the Pseudozygopleurinae are discussed and the derivation of the sub-family is suggested.

Explosive evolution in the Pseudozygopleurinae is not confined to the larger taxonomic units but is also expressed in a large number of species, many of which may be found within very narrow stratigraphic units. The significance of the latter fact is discussed. Fifty-six species, fifty-four of them new, are described and figured.

A columnar section of the St. Louis Pennsylvanian outlier from which the collections were made is presented with correlations.

INTRODUCTION

Professor Schuchert's term "explosive evolution" is very descriptive of the tremendous multiplication of species and groups of higher taxonomic rank that seems to have suddenly occurred from time to time

in various lines of descent. The ammonites of the Mesozoic are a classic example. Such rapid evolution has a three-fold interest for paleontologists. It provides a multitude of short-ranging forms useful as guide fossils; it affords a means of testing morphological criteria used in taxonomy; and it presents a tremendously interesting problem in evolution.

Many zones in the American Pennsylvanian strata afford a host of small gastropods in which there is a most confusing array of species. Even scores of closely similar species are associated in a relatively thin layer as though they had lived together. Although a similar array is occasionally met with under diversified ecological conditions in existing seas and oceans, such remain largely unknown to all but the most painstaking collectors.

Just as this modern fauna of tiny forms remains unobserved by the collector who does not search minutely amongst the fronds of the littoral vegetation, or wash and examine microscopically dredgings from deeper waters, so are many of these fossil forms unknown to the paleontologist working an outcrop with hammer and chisel intent upon only the more familiar and conspicuous fossils. Nevertheless among these minute forms are to be found many of the most interesting and significant fossils.

That such a host of forms has remained so long largely unknown is not necessarily the fault of the field paleontologist. His purposes are generally largely stratigraphic and he is primarily intent on finding previously known and described guide fossils. Again, the nature of the strata are only locally of such a character as to yield these smaller fossils. And finally, given the intent to study a fossil fauna completely and the comparatively rare combination of lithology and preservation that are requisite, the required technique of collecting and preparing has until recent years been actually practiced by only a few.

After the economic value of micropaleontology was realized by the petroleum industry, micropaleontological technique was not only highly developed but became a part of the equipment of many. To the paleontologist the washing of shales, shale partings, the decomposition products of limestone and even of the friable weathered rock itself are the literal as well as the technical counterpart of the marine zoölogist's dredge washings and are yielding similar results. The marine zoölogist may study the life he washes from the sediments of our oceans of to-day; the paleontologist may study likewise the remains of life he washes from the sediments of the oceans of the past.

Due to their obvious utility in subsurface correlations the foraminifera and ostracoda have chiefly claimed the attention of micropaleontologists and although minute gastropods are frequently met with

in washings from well samples they have been totally neglected. The limited discussion of the small gastropods in the literature is the work of paleontologists having less immediate economic objectives and commonly has to do with the more conspicuous forms only. It seems proper to remark here that there can be little doubt that gastropods small enough to escape destruction by the drill will become economically useful in exact proportion as they become known and specifically identifiable and as their stratigraphic range becomes established. This paper will deal exclusively with one group of such gastropods that not only has many microscopic species, but which seems to be undergoing an amazing explosive evolution that should lend itself admirably to the development of zone fossils. The members of this group are moreover, at least locally, amongst the most abundant gastropods of Pennsylvanian strata. It is to be regretted that the collections on which these studies are based are from a stratigraphic range too short to establish limits for any of the species, or to lend the confirmation of the time element to the taxonomic ideas suggested. It is hoped, however, that they will form a systematic foundation upon which the more useful complete structure can later be erected.

This paper will deal largely with some of the slitless, high-spired gastropods of the Pennsylvanian that in a broad way may be called loxonematoid, that is, which display characters that unite them superficially at least with the genus *Loxonema* Phillips. These characters are a high, many-whorled spire, an imperforate base and a more or less sinuate outer lip. While at the very first such species as were known were placed in various genera, some of which are now known not to extend back beyond the Tertiary, nearly all of them came in time to be referred to *Loxonema*. Then *Aclisina* De Koninck became a catch-all for such of them as had revolving ornamentation until Mrs. Longstaff (formerly Miss Donald) in a beautiful piece of work(2)[1] put that genus on a firm footing. After Koken defined the genus *Zygopleura* in 1892 (3, b) all species ornamented throughout with transverse costae were transferred thereto. This left a group of more or less unornamented shells, the systematic position of which has been quite doubtful. Some still stand in the literature referred to *Loxonema* in spite of the fact that Mrs. Longstaff(4) has shown that genus to possess characters that should exclude these Pennsylvanian forms. And yet what to do with them has indeed seemed

[1]Numbers refer to articles listed in the Bibliography at the end of the paper.

a difficult problem. Some of them will probably find place with *Streptacis* Meek; some will be further considered here. It seems highly improbable that *Loxonema* in the strict sense continued into the Carboniferous.

Gastropods are truly a difficult group for the paleontologist. The natural classification is based primarily on soft parts, which are of course unavailable and which are reflected in the shell only to a minor degree. The paleontologist then, being without much morphological data must give special attention to ontogeny that is shown in the shell. When the ontogenetic record is clear it is of the first importance as evidence of relationship. However, here again are often practical difficulties. The apical portion which shows the early ontogeny of a gastropod shell is rarely well preserved, and if preserved is commonly too simple to be of much significance. Nevertheless when well preserved and distinctive nuclei are available they are of highest value in interpreting the taxonomic relationship of the forms that possess them.

I have been fortunate enough to find in the Pennsylvanian outlier at St. Louis, Missouri, two distinct but stratigraphically adjacent shale zones in thich the preservation of the smaller molluscs is exceptionally fine, and by dint of washing large quantities of the shales have succeeded in collecting a great number of beautifully preserved specimens. Not only do some specimens of most of the species of gastropods in the collection retain nuclei with all details preserved but an astonishingly large number of them from these and one other zone retain their color markings. This abundant and beautifully preserved material has enabled me to solve some heretofore perplexing taxonomic problems and serves to illustrate again the value of nuclei for indicating relationships and the dangers of relying too exclusively on adult morphology.

My collections are all from the fairly large outlier of Pennsylvanian strata in the city and county of St. Louis, Missouri, a collecting ground for some of the earlier workers in Pennsylvanian paleontology but one sadly neglected for over sixty years. The section ranges stratigraphically from a basal sandstone just below the underclay of the Bevier coal of the Cherokee formation up through the whole of the Henrietta formation and well into the heavy micaceous sandstone marking a widespread and rather conspicuous erosional unconformity in the Pleasanton formation in Missouri. Figure 1 gives a generalized picture of the section and of its correlations in terms of both the Eastern and Western Interior coal basins(5)[2].

[2]It will be noted that the writer's correlations agree in a general way with the broader correlations of Savage(21) However, they were made independently.

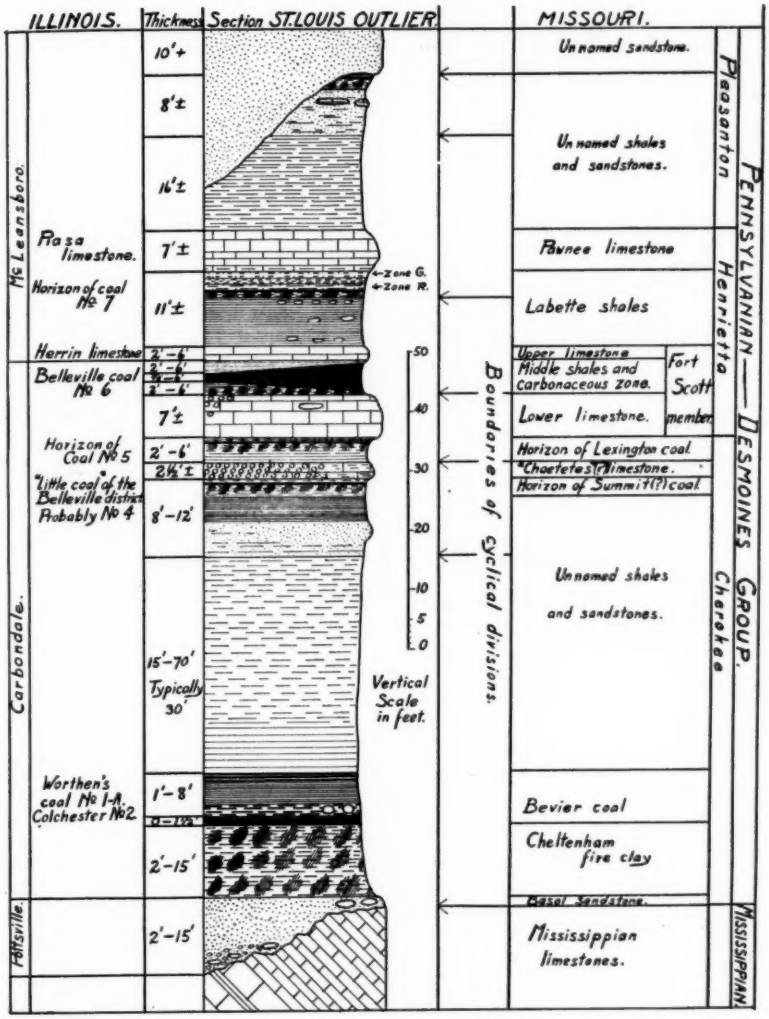


FIG. 1. Stratigraphic section and correlation of the St. Louis, Missouri, Pennsylvanian outlier.

The bulk of the molluscs in the collections, particularly those that are so exceptionally well preserved, were derived from the upper four feet of the Labette shale and lower two feet of the Pawnee limestone. A very few were derived from the lower Fort Scott limestone.

OBSERVATIONS ON THE GENUS *ZYGOPLEURA*

The minute gastropods to be considered in this paper suggest the genus *Zygopleura* to which, it will be recalled, the Pennsylvanian loxonematoid gastropods with transverse costae to-day are commonly referred. Koken established the genus in 1892 (3a-b) to distinguish the loxonematoid group of *Turritella hybrida* (Münster) which he had previously isolated as a natural section of the genus *Loxonema* as then understood(6). Although at the time he established the genus he seems to have had before him only shells from the Alpine middle Triassic, he extended the genus backward as far as the Devonian to include species having the same general form and ornamentation, and his action in this respect has been very generally followed, particularly by European workers. It must be borne in mind, however, that the genotype *Z. hybrida* (Münster) is a Triassic form and that Koken's generic diagnosis applied specifically to that and the other Triassic species. In fact, when describing the nuclear characteristics of the shells of his new genus, he remarks parenthetically and with commendable exactitude, that the description of this feature applied to "*Zygopleura hybrida, Z. nodosoplicata* and other Triassic species observed." The nuclei of the Paleozoic species seem to have been unknown to him but they were assililated into the genus because of the quite obvious resemblance of the mature shells to his Triassic forms.

Koken's generic diagnosis (3b, p. 30) reads as follows:

> *Zygopleura* n. sp. (Gruppe der *Turritella hybrida* m. olim.)
> Umgänge mehr oder weniger gewölbt, mit deutlich nach vorn concaven Querfalten, die sich auf der Schlusswindung in feine Rippen oder Bündel solcher mit *Loxonema*-ähnlicher Biegung auflösen. Embryonalgewinde glatt, gewölbt (bei *Z. hybrida, nodosoplicata* Mrr. u. a. triassischen Arten beobachtet). Mündung gewöhnlich mit Ausguss.

The significant point of the diagnosis for the purposes of this discussion is the entirely smooth embryonic spire. In another place (6, p. 442) Koken illustrates the smooth nucleus (See Pl. 5, fig. 9). The nucleus is the embryonic or nepionic spire, not the protoconch in the restricted sense, the latter being smooth in virtually if not quite all gastropods and therefore of little phylogenetic significance. Although further confirmation of the correctness of Koken's description of the nucleus is hardly necessary, it happens that in a collection of Alpine Triassic material (St. Cassian) at Peabody Museum there are numerous specimens of true *Zygopleura* some of which display well preserved nuclei. Fig. 10, Plate 5 shows a photomicrograph of *Z. arctecostata* (Münster) specifically

identified at the hand of the late Professor Ernst Kittl of Vienna. Its nucleus, which preserves every detail including the finest lines of growth, is composed of five smooth, unornamented volutions, followed immediately by whorls having strong, typical zygopleuroid costae. The nuclear lines of growth show little sinuosity.

THE PENNSYLVANIAN ZYGOPLEUROIDS

As far as I can learn the name *Zygopleura* was introduced into American literature in 1908 by Girty (7, p. 485) for a poorly preserved specimen from the Texas Permian. Girty in 1915 gave the American species which seemed referable to the genus detailed consideration (8, pp. 182-185), and his assignment of Pennsylvanian and Permian species to this genus established a precedent that has been universally followed. He gave no consideration to nuclei and it is very doubtful if the preservation of the Wewoka specimens was sufficiently good to have permitted him to do so. We can glean from the literature almost nothing as to the nuclei of pre-Triassic zyglopleuroid gastropods. Those assiduous collectors and keen observers, Meek and Worthen, did notice and figure the nuclei of a few Pennsylvanian forms from Illinois, (9, Pl. 29, figs. 2a-b, 3a-b, 4a-b) but were only interested as to whether or not they were heterostrophic and do not describe or discuss them other than to remark the direction of coiling. One nucleus figured by them belongs to a fully costate zygopleuroid form (un-named), one to a partly costate form, "*Loxonema*" *semicostata* Meek (see Pl. 1, fig. 1a and Pl. 5, fig. 14), and a third to a form, again un-named, that carries no post-nepionic costae whatever.

As previously stated, at least some specimens of most of the many gastropod species in my collection have well preserved nuclei. Plate 5, fig. 11, shows the nucleus of a form of the type referred so commonly to *Zygopleura;* fig. 13 on the same plate shows even more clearly an entire nepionic shell of such a form, in all probability that of an individual just as it emerged from the egg case. The nepionic spire, with the exception of the phylembryonic first whorl, is ornamented in a most distinctive fashion with strong, rather sharp costae which display what may be called an exaggerated loxonematoid sinuosity. The examination of many specimens has show that the transition from the sharp and strongly sinuate nepionic costae to the relatively broad and weakly sinuate neanic costae is abrupt. There is no intergradation. The two or three whorls that bear these costae must be regarded as purely nepionic, i. e., as something distinct from the whorls that follow. Their very

distinctive sculpture is something peculiar to their ontogenetic stage and not simply an exaggerated forecast of the mature ornamentation. Moreover these nuclear whorls are often pigmented differently than those that follow. Plate 5, fig. 12, shows this quite clearly. The nucleus is quite black and the black pigment is confined to the whorls bearing the nuclear ornamentation. The pigmentation ceases at the same point as the nuclear ornamentation and as abruptly.

The facts are these: the nucleus of *Zygopleura* is smooth and without ornamentation; that of the Pennsylvanian zygopleuroid forms highly and distinctively ornamented. To those who give any recognition to the law of recapitulation it will be obvious that the Pennsylvanian species are not genetically related to the Triassic forms but are merely homeomorphs. The characters heretofore chiefly relied upon to associate the two groups, namely high spire, transverse costae, loxonematoid outer lip, etc., are repeated again and again amongst gastropods of very diverse relationship, and truly cannot have the taxonomic significance they have been accorded. As a study of the Pennsylvanian forms here considered will show, these characters have, at least amongst those forms, only a very low order of taxonomic significance indeed. In no group are the pitfalls of homeomorphy more to be guarded against than in fossil gastropoda!

THE PSEUDOZYGOPLEURINAE

The discussion up to this point has been confined strictly to zygopleuroid forms, that is to forms having at post-nepionic stages the form and ornamentation of the true Triassic members of that genus. But that is far from being the whole story. The highly distinctive, quite unique nucleus of the Pennsylvanian zygopleuroids is not confined to species displaying zygopleuroid form and ornamentation at adult stages of development. It is found also on partially or wholly smooth species, on species with revolving ornamentation alone, on very high-spired, tightly coiled, cylindrical species, on relatively low sub-turbinate ones and on species which are entirely unrolled, on species with a typically loxonematoid outer lip and characteristic anterior extension and on species with the outer lip passing obliquely backward from the suture with no trace of a sinus. Photomicrographs of some of these various forms showing the characteristically ornamented nuclei are shown on Plate 4, fig. 3-b, and Plate 5, figs. 6, 11, 15 and 16. Others, not enlarged sufficiently to show the nuclei may be found on the other plates.

After studying the nuclei of many specimens of all these various Pennsylvanian types one cannot avoid the conclusion that they are

very closely related indeed in spite of their difference in adult expression, so closely in fact that there is some question as to whether the group as a whole should be given simply generic or a higher rank. At the time the preliminary announcement of these facts was made (10) I was inclined to group them all as one genus with various subgeneric designations for the groups with differing adult expression. Further study however has shown that the subgenera could be conveniently and naturally grouped into four main divisions which are here given generic rank while it has been thought best to give the group as a whole the status of a sub-family, the Pseudozygopleurinae, shortly to be defined. This sub-family is tentatively referred to the Loxonematidae of Koken, rather than the Pyramidellidae. The reference to the Paleozoic loxonematoid forms, all of them with dextral nuclei and in all probability not even genetically related amongst themselves, to the Pyramidellidae, (12, 13 and others) a closely knit unit when viewed narrowly, is entirely artificial and harmful to the basic concepts of taxonomy.

The nuclei of the pre-Triassic loxonematoids has apparently not been observed by the European workers largely responsible for the current classifications. With one exception I have been unable to find any reference to it in the works of Perner, Koken, Cossman or Longstaff, or in the works of others. The single exception is *Kataptychia* Perner which has a smooth, unornamented nucleus. (11, Pt. 2, p. 348) In the American literature, however, aside from the Pennsylvanian nuclei here under consideration, Clarke (13, p. 332, Pl. 18, figs. 6-10) describes and figures the nucleus of a Devonian species, *Loxonema noe*. It is smooth and with no very sharp line of division between the nuclear and the mature ornamentation. Assuming that *L. noe* is congeneric with *Loxonema sinuosum* the genotype, its nucleus may be considered as representative. Now the mature whorls of *Loxonema* (*ss.*) carry a much more highly sinuate outer lip than the comparable whorls of the Pseudozygopleurinae. It seems plausible then to look upon the latter as being derived from the former, and as having been modified by tachygenetic pushing forward of the mature characters of *Loxonema* onto the nuclear stages of the Pseudozygopleurinae and the introduction into the later ontogenetic stages of the various characters and tendencies displayed in this sub-family. If this be true, the real Zygopleurae of the Triassic are not derivable from the Pennsylvanian and Permian Pseudozygopleurinae. They seem at least superficially to have much in common with *Loxonema* of the earlier Paleozoic and may have been derived from it through some line independent of the Pseudozygopleurinae, some

line in which tachygenesis was not operative; and yet there is a long hiatus from Devonian to Triassic during which no connecting links are known. The taxonomic position of the Mississiippian loxonematoid shells must remain in doubt until their nuclei become known, though they will probably find a place with the Pseudozygopleurinae rather than *Loxonema*. It seems probable, in view of this hiatus and of the frequent recurrence of loxonematoid and zygopleuroid homeomorphs of entirely distinct ancestry, that *Zygopleura* has had an entirely different derivation. Figure 2 is intended to express these concepts graphically.

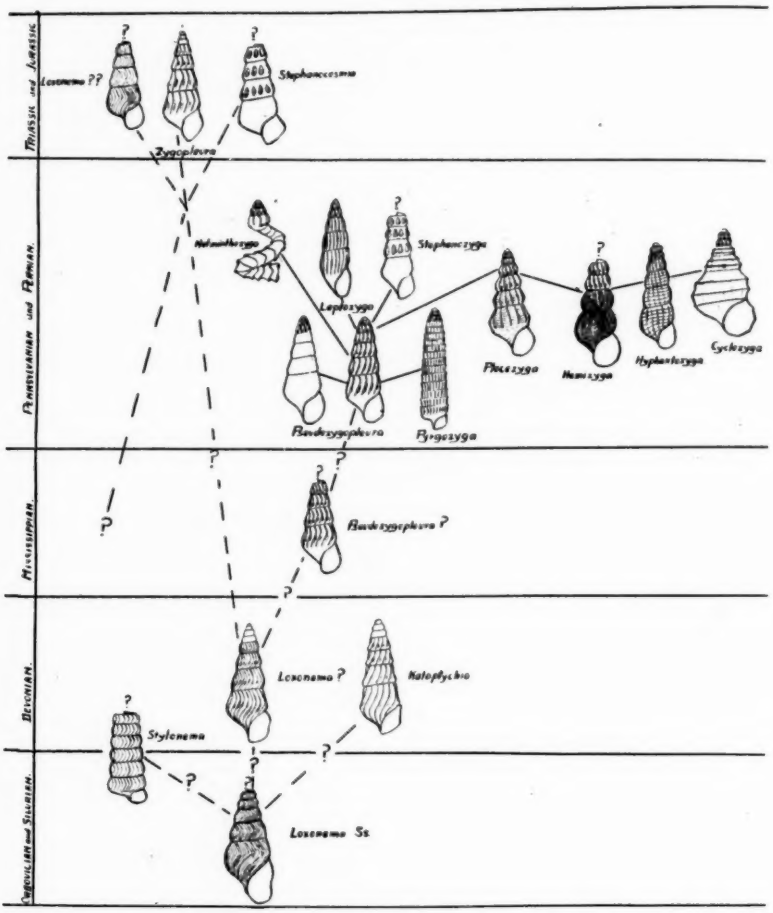


FIG. 2. Graphic representation of the suggested derivation of the Paleozoic loxonematoids.

Before giving more detailed consideration to the various generic and subgeneric divisions of the Pseudozygopleurinae it may be well to define the proposed sub-family which will bear the name of its morphologically and phylogenetically typical genus.

SUB-FAMILY PSEUDOZYGOPLEURINAE KNIGHT, NEW SUB-FAMILY

The forms included in this family are all characterized and united by the possession of a minute, rather high-spired nucleus, coiled in the same direction as the later volutions and normally composed of about three and one-half whorls, all but the first of which (the smooth protoconch) are ornamented by costae which run transverse to the whorls, and have a strong sigmoidal curvature. The nuclear costae on a typical specimen (Plate 5, fig. 13) arise at the upper suture and pass obliquely backward at an angle of about 25 degrees for about three-quarters of the distance from suture to suture, when they curve rather sharply forward and run almost parallel with the suture for a short space, somewhat less than one-fifth of the suture-to-suture distance, then obliquely forward and downward at an angle of about 55 degrees from the vertical for a little more than one-fifth of the same distance, where they turn rather sharply downward and forward at an angle of about 8 degrees from the vertical and continue to a point a little more than one-fifth of the suture-to-suture distance below the line of the lower suture where they merge into the smooth base. The edge of the outer lip at nepionic stages is believed to parallel the course of the costae. The lower part of each costa is commonly so placed that on cursory inspection it seems to be the direct downward continuation of the next costa forward, thus giving the appearance of a simple rib with a relatively shallow and smooth posterior convexity, while the sub-horizontal portions of the costae give the effect of forming a continuous revolving rib, or the lower "thread" delimiting a slit band for which there is no counterpart above. The lower course of the costae is of course only to be seen on the nepionic shells as they are covered to a greater or less degree in different species by the next later whorl. The base of the nucleus is unornamented and imperforate, the peristome incomplete, while the aperture is rounded below and more or less angulated above where the outer lip meets the next superior whorl. Although different species and specific groups may possess nuclei varying in minor details from this description, they all conform to the general plan. Although the transition from the nepionic nuclear ornamentation to that of the neanic shell is quite abrupt, no varix at this

point has been observed. When the conditions of fossilization are sufficiently favorable to preserve colors the nucleus is commonly found to be darker than the following volutions.

The adult shell is typically high-spired and many-whorled but there is considerable variation in both respects. Typically the shell is dextral, the base is imperforate and the columellar lip thin and slightly reflexed, but there are exceptions to all these conditions. The columella is without folds. The peristome is typically incomplete, the aperture rounded to flattened below and angular above. The outer lip in the typical genus bears a shallow loxonematoid sinus but in other genera it may pass obliquely backward to form a trochoid aperture without a trace of sinuosity. The post-nepionic ornamentation varies. In the typical genus it consists of more or less sinuaate transverse costae which in some species are partially or wholly suppressed. Other genera display revolving lirae or ridges alone or in combination with transverse costae. The shell is rather thick and there is no evidence of a true nacreous layer. The earlier whorls seem to have been very gradually filled with secondary shell matter which was built up from all sides inward thus gradually constricting the opening.

The Pseudozygopleurinae are distinguished from homeomorphic genera pricipally by their nuclei. If nuclei are lacking or poorly preserved, definite assignment may be virtually impossible. However there are few genera among the forms associated with the Pseudozygopleurinae in American Pennsylvanian strata with which the latter might be confused. *Streptacis* Meek and *Aclisina* De Koninck are characterized by their nuclei and by a highly sinuate outer lip at adult stages. These and the group including *Soleniscus* Meek and Worthen, *Macrochilina* Bayle, *Bulimorpha* Whitfield and *Sphaerodoma* Keyes will be discussed in later papers. They are characterized as a rule by a less attenuated form more extended anteriorly, by a columellar callus and fold and a notched anterior margin. And yet in the case of high-spired forms of this group in which the typical characters are more or less repressed the line may be difficult to draw without knowledge of the nuclei. Some of the lower spired species resemble *Naticella* Münster somewhat though they are seldom so globose, and it seems quite possible that the Pennsylvanian forms referred to *Naticella* may belong here. And finally, some of the forms presently to be described under the new genus, *Cyclozyga*, resemble superficially Carboniferous shells that have been referred in the past to *Cyclonema;* they differ not only in respect to their nuclei but in that the latter forms, at least as far as observed by me, have a distinctly two-layered shell, the inner layer presumably being nacreous.

Neither true *Holopea* Hall nor *Holopella* M'Coy are known from American Pennsylvanian strata. The last genus indeed can hardly be regarded as well established.

It has been found convenient to divide the Pseudozygopleurinae into four genera and two of these again into four and three subgenera respectively on the basis of what appears to be a natural orthogenetic evolution in their adult characters. These genera and subgenera will now be defined.

GENUS PSEUDOZYGOPLEURA KNIGHT, EMEND.

Typically high-spired, many-whorled gastropods with the characters of the sub-family and with post-nuclear ornamentation confined to transverse costae which extend only a little way if at all onto the smooth base below the line of suture. They are typically dextral, although one sinistral species is included. The outer lip has typically a broad, shallow, sub-median sinus below which it is slightly extended anteriorly as in the genus *Loxonema;* but in *Pseudozygopleura* this character often finds little or no expression. The costae may be obsolete on the later whorls or on all post-nuclear whorls, resulting in the latter case in shells that are smooth. The inner lip is thin and slightly reflexed.

The genotype is *Loxonema semicostatum* Meek (not *L. semicostatum* De Koninck).

The name is chosen for two reasons; it calls to mind the genus *Zygopleura* which the more typical and abundant species resemble so closely, and carries with it a mnemonic reference to the name under which such species have of late years become established in the literature.

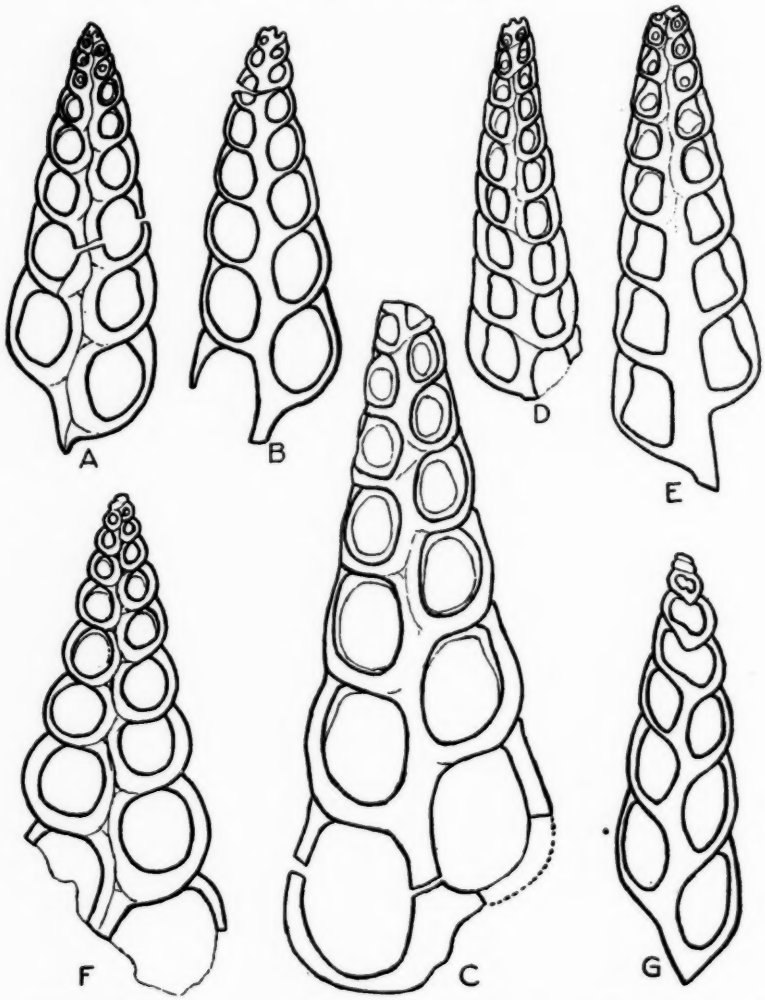
As originally proposed (10) this genus was intended to embrace within its limits as subgeneric divisions those species with both transverse costae and revolving lirae or with revolving ornamentation alone. For various reasons it has been thought best to separate those forms as independent though closely related genera and to restrict the present genus to forms without revolving ornamentation.

SUBGENUS PSEUDOZYGOPLEURA (SENSU STRICTO) KNIGHT, N. SUBG.

Pseudozygopleurae with gently to strongly rounded and in some species pendant whorl profiles which may be adpressed but not shouldered. The base is short and may be either flatly or evenly rounded. Columellar sections of paratype specimens of several species (Fig. 3A-C) of

the subgenus show characters that seem to differentiate it from some of the other genera and subgenera. The columella is slightly though not markedly arcuate, the opening rather broadly ovoid and only slightly if at all constricted medially by thickening of the outer wall.

The sub-genotype is the same as the genotype.



A, *Pseudozygopleura leveneae* Knight. B, *Pseudozygopleura kellettae* Knight. C, *Pseudozygopleura scitula* (Meek and Worthen). D, *Pyrgozyga macra* Knight. E, *Pyrgozyga dunbari* Knight. F, *Plocezyga angularis* Knight. G, *Leptozyga minuta* Knight.

Figure 3. Columellar sections of Pseudozygopleurinae.

SUBGENUS STEPHANOZYGA KNIGHT, N. SUBG.

This subgenus is established to include a series of species in which there is an orthogenetic tendency for the costae to be suppressed at either end resulting in a median band of transversely extended nodes. On no known species are the costae entirely suppressed except on the final volution and yet the loss of costae or nodes at this point seems to be almost characteristic.

Too few specimens of members of this subgenus are at hand to permit the sacrificing of one for sections. Since no example preserves a nucleus there is some uncertainty of the association of this group with *Pseudozygopleura*, and even its distinctness from the Triassic genus *Stephanocosmia* Cossman (=*Coronaria* Koken). Nevertheless its close similarity to and physical association with the abundant species of Pseudozygopleurinae in the Pennsylvanian, so remarkably in a state of evolutional mobility, is considered as of greater weight than its morphollogical similarity to *Stephanocosmia*. *Stephanocosmia* is considered to be another example of the quite remarkable homeomorphy existing between Pennsylvanian and Permian Pseudozygopleurae and the Triassic Zygopleurae. The name is derived from the Greek στεφην (crown) and the syllable -zyga.

Zygopleura nodosa Girty is designated as the genotype.

While too few species are known as yet to draw any definite conclusions, it is suggestive that on the form here described the costae are less contracted than in *S. nodosa* from the Shawnee group higher up in the Pennsylvanian, while on an undescribed form in a collection of basal Permian material from Texas at Peabody Museum collected by Robert King the truly node-like costae are limited to the very center of the whorl. It is to be hoped that this apparent orthogenetic shortening of the costae in the species of this subgenus will prove to be of value in stratigraphic work.

SUBGENUS PYRGOZYGA KNIGHT, N. SUBG.

Pseudozygopleurae with numerous, more or less shouldered whorls a straight, pillar-like columella, and a sub-quadrate whorl section. Columellar sections (Fig. 3, D, E.) show a straight pillar-like columella and an elongate sub-rhombic opening typically constricted medially by a thickening of the outer wall.

The subgenotype is *Pseudozygopleura* (*Pyrgozyga*) *cylindrata* Knight, n. sp.

The name is from the Greek πυργος (tower) and the syllable -zyga.

SUBGENUS LEPTOZYGA KNIGHT, N. SUBG.

To this subgenus is referred a single known species which seems widely enough separated from the typical subgenus to preclude its inclusion therein. For the present, then, the subgenus may be considered as embracing forms that have the characters that appear to set the genotype apart from the more typical forms. These are minute in size, extremely fine transverse costae or lirae, a rather extended subconical base and a somewhat elongated aperture. The columella is markedly arcuate and the opening elongate-ovoid as shown in columellar section (Fig. 3, G).

The subgenotype is *Pseudozygopleura* (*Leptozyga*) *minuta* Knight, n. sp.

The name is derived from the Greek λεπτος (fine of texture) and the syllable -zyga.

GENUS HELMINTHOZYGA KNIGHT, N. G.

This genus is proposed to accommodate a single known species, *H. vermicula* Knight, n. sp., which after passing through a few normally coiled post-nepionic whorls, begins to uncoil until it becomes in this respect quite like *Vermetus* of much younger horizons. The transverse costae on the genotype become more and more varix-like and extended as the point of uncoiling is approached until on the uncoiled parts they become plate-like frills inclined somewhat toward the aperture. The aperture at these later stages became periodically flaring and bell-like, the flaring extension of past stages forming the frill-like costae.

What mode of life or environmental conditions could have brought about such an unusual modification within a group of closely coiled shells can hardly be surmised. There are no signs of attachment.

Frech (14) has postulated that such uncoiled genera as *Vermetus* and *Siliquaria* resulted from acquisition of the habit of living within sponges where the peculiar environment brought about the new type of coiling. This seems a plausible explanation for *Helminthozyga* as well. It may well be that the variation shown by different individuals as to when uncoiling takes place simply reflects the point in the individual's development when it succeeded in becoming established in a host. This suggestion is given some additional weight by the fact that specimens have only been found in a narrow zone containing rather numerous sponges whereas both sponges and *Helminthozyga* are lacking in a faunally similar but not identical zine only a few inches below.

The name is from the Greek ἑλμινθος (worm), and the syllable -zyga.

The genotype is the only known species, *Helminthozyga vermicula* Knight.

GENUS HEMIZYGA GIRTY, EMEND. KNIGHT

This genus was established by Girty (15, p. 361) as a subgenus of *Zygopleura* to embrace forms which he distinguished by two characters. First they were supposed to pass through a relatively coarsely costate "*Zygopleura*" stage which comprised the major portion of the shell, followed by the later whorls on which the zygopleuroid costae were said to subside into more crowded lines of growth. The second character was the introduction of revolving striae, presumably at the stage where the change in the nature of the costae took place. Girty describes for his new genus three species (without designating a genotype) and refers to it, although somewhat tentatively, three forms previously described by Mark (16, pp. 315-316, Pl. 16, figs. 11, 12, 13) and doubtfully referred by her to the genus *Aclisina*. Since Girty was uncertain of his first described species, *H. dubia*, I will select the next, *H. elegans* Girty as the genotype.

The genus may be subdivided into three subgenera upon two of which the characteristic nucleus has been observed. Unfortunately the current interpretation of the Laws of Priority demands that the genotype and the typical subgenus must be the ones upon which in this case the actual nucleus has not been observed, but for which it seems safe enough to infer it.

I would redefine *Hemizyga* as Pseudozygopleurinae which typically display revolving lirae (or striae) superimposed upon transverse costae. The loxonematoid sinus in the outer lip is typically obsolescent so that the transverse costae pass obliquely backward and downward from the suture with little or no sinuosity. The whorl profile is typically well arched and the sutures deep. The foregoing characters are shown by most species but there are a few in which some one or the other of them is not developed, but which are certainly Hemizygae. The columellar lip is thin and reflexed or it may be thickened and almost callused.

SUBGENUS PLOCEZYGA KNIGHT, N. SP.

Hemizygae with strong transverse costae that are confined to the sides of the volution, and with fine revolving lirae on the sides and base. The columellar section shows a slightly arcuate columella, a sub-circular

opening and a relatively thin outer wall with no localized thickening (Fig. 3, F). The pseudozygopleuroid nucleus has been observed in numerous specimens.

The subgenotype is *Hemizyga* (*Plocezyga*) *corona* Knight, n. sp.

The name is derived from the Greek πλοκη (web) and the syllable *-zyga.*

This subgenus seems to represent the most primitive expression of the forms carrying revolving ornamentation. They are simply Pseudozygopleurae with fine revolving lirae. There is however a further suggestion of change in that the sinuation and forward extension of the outer lip as expressed in the course of the costae seems to be much less in *Plocezyga* than in typical *Pseudozygopleura.* The costae of *Plocezyga* typically proceed obliquely backward from the upper suture, with little sinuosity thus reversing the direction of the obliquity which is typical of *Pseudozygopleura.*

In addition to the species described in the following pages I would refer to *Plocezyga* from the literature, *Hemizyga dubia* Girty and somewhat more doubtfully *"Aclisina?" costata* Mark and *"Aclisina?" ornata* Mark. The last two need more characterization before one can treat them with any confidence.

Subgenus HEMIZYGA Girty, s. s.

Hemzygae with transverse costae that are stronger than the revolving lirae at least on the earlier whorls, and that are not confined to the sides of the whorls but at least on the later volutions pass completely across the base of the columellar lip. It did not seem wise to destroy any of the few specimens of this subgenus in order to obtain a columellar section.

The subgenotype is the same as that of the genus, *H. elegans* Girty.

To this subgenus I would refer from the literature *H. grandicostata* Girty and perhaps *"Aclisina?" cancellata* (Mark) although the latter is inadequately described. As far as one can tell from the illustration, *"Hemizyga"* n. sp. figured by Plummer and Moore is not to be placed in either the genus or the subgenus.

Subgenus HYPHANTOZYGA Knight, n. subg.

The subgenus *Hyphantozyga* is erected to embrace such Hemizygae as have progressed much further along the lines of the weakening of the transverse costae and strengthening of the revolving lirae. The transverse and the revolving ribs are in this group subequal at all post-nuclear stages of development and cover the base as well as the sides of the whorls.

This appearance of a coarsely woven cloth given by the two sets of ribs running at approximately right angles to one another has suggested the name of the subgenus which is derived from the Greek ὑφαντος (woven) and the syllable *-zyga*. Too few specimens are at hand to allow the preparation of sections. The nucleus, which has been seen, is entirely characteristic of the Pseudozygopleurinae.

The subgenotype is *Hemizyga* (*Hyphantozyga*) *gracilis* Knight, n. sp.

GENUS CYCLOZYGA KNIGHT, N. G.

To this genus are referred two species which may be regarded as the climax of the *Plocezyga→Hemizyga→Hyphantozyga* line of orthogenetic changes in that it is completely without transverse ornamentation, or at most the transverse lines are very weak in comparison with the few, strong revolving ribs or keels. It is thought that these, the end members of the series, are sufficiently removed to deserve full generic rank. Both the form and the aperture are decidedly trochoid in expression, there being no trace whatever of a loxonematoid sinus in the outer lip which sweeps obliquely backward and downward. The name, of course, has reference to the revolving ornamentation.

The pseudozygopleuroid nucleus has been observed on a number of specimens of both species here described, and it presents a remarkable and striking contrast to the post-nuclear volutious with their wide, low, revolving ridges or keels.

EVOLUTION WITHIN THE PSEUDOZYGOPLEURINAE

From the preceding description it will be seen that from a genetic point of view we have first in this interesting group of gastropods the subgenus *Pseudozygopleura*, which because of its closer resemblance to the ancestral type, indicated by both the nuclear and mature form of ornamentation, is regarded as forming the stem group. Then, derived from this stem we find six different lines of evolution. The first of these, the loss of costation, seems to have arisen in several different groups and it did not progress far enough to bring about clean separations. Hence the forms that show it are not segregated as separate groups. Three more lines expressed in *Stephanozyga*, *Pyrgozyga* and *Leptozyga* although seemingly distinct natural groups have not progressed far on their paths and are here considered of subgeneric significance. The fifth line represented in *Helminthozyga* seems distinctive enough to deserve generic rank.

The line, or rather group of lines, finding expression in the *Plocezyga→Hemizyga→Hyphantozyga→Cyclozyga* sequence exhibit clearly at least four progressive tendencies each of which is more strongly emphasized in the order named. These are the introduction and progressive development of revolving lirae, the extension of the transverse costae onto the base, the weakening and final complete elimination of the transverse costae and the conversion of the loxonematoid outer lip into one that is almost trochoid in expression.

What might perhaps be taken as a seventh line is exemplified in the typical species *Pseudozygopleura perversa* Knight, although the reversal of direction of coiling is not thought in this instance to deserve more than specific recognition. The discovery of other sinistral species showing correlated affinities to *P. perversa* would, however, justify such action. These concepts are set forth graphically in Fig. 4.

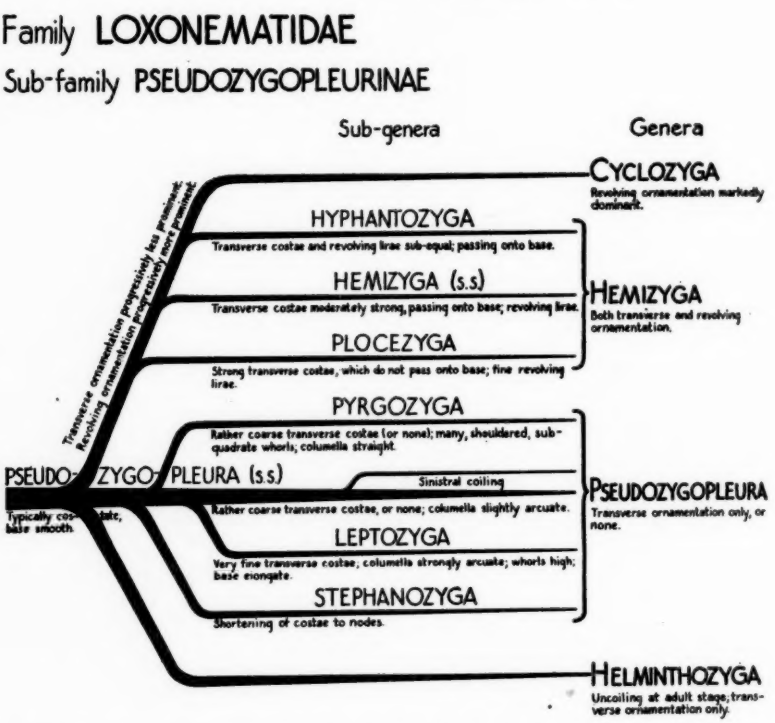

Family LOXONEMATIDAE
Sub-family PSEUDOZYGOPLEURINAE
Sub-genera
Genera
CYCLOZYGA
Revolving ornamentation markedly dominant.
HYPHANTOZYGA
Transverse costae and revolving lirae sub-equal; passing onto base.
HEMIZYGA (s.s.)
Transverse costae moderately strong, passing onto base; revolving lirae.
HEMIZYGA
Both transverse and revolving ornamentation.
PLOCEZYGA
Strong transverse costae, which do not pass onto base; fine revolving lirae.
Transverse ornamentation progressively less prominent
Revolving ornamentation progressively more prominent
PYRGOZYGA
Rather coarse transverse costae (or none); many, shouldered, sub-quadrate whorls; columella straight.
PSEUDO- ZYGO- PLEURA (s.s.)
Sinistral coiling
PSEUDOZYGOPLEURA
Transverse ornamentation only, or none.
Typically co- state, base smooth.
Rather coarse transverse costae, or none; columella slightly arcuate.
LEPTOZYGA
Very fine transverse costae; columella strongly arcuate; whorls high; base elongate.
STEPHANOZYGA
Shortening of costae to nodes.
HELMINTHOZYGA
Uncoiling at adult stage; transverse ornamentation only.

FIG. 4. Diagrammatic representation of the evolution within the Pseudozygopleurinae.

A key to the genera and subgenera of the Pseudozygopleurinae is given on page ~~000~~. 30

EXPLOSIVE EVOLUTION AS EXPRESSED IN THE SPECIES

Specific variation in this group is even more amazing than the generic divergences. Among the nine generic and subgeneric divisions in the relatively restricted stratigraphic and geographic limits from which my collections come we have no less than fifty-six well defined lesser units. And these units are in the main compact ones differentiated on the basis of correlated criteria that *must* have significance unless we are to cast them aside entirely and consider each of the major groups to contain only one highly variable species. The latter is unbelievable. The minor groups so similar on first sight are on close study found to be too compact to permit of such an interpretation. I shall not enter into the question whether these lesser units are specific or varietal or partly one and partly the other. They are nameable units that will no doubt eventually prove to have stratigraphic value. I feel that experimentation, obviously impossible with fossils, yields the only valid criteria for distinguishing degrees of relationship usually expressed as sub-specific or varietal. If this is true the naming of varieties by paleontological workers involves in many if not most cases assumptions that are usually entirely unwarranted by any other than the weak evidence of the degree of morphological similarity of skeletal parts. The simple specific name assumes the least, is equally useful stratigraphically and is far less cumbersone. The placing of one form as a variety of another assumes more detailed knowledge of the exact degree of relationship between the two forms than does the application of a name that simply implies a difference and, furthermore, such detailed knowledge is usually not available to paleontologists.

A brief survey of the American literature dealing with the Pennsylvanian and Permian shows a total of twenty-one specific names and five forms figured as undetermined species that are quite certainly referable to the Pseudozygopleurinae. Thirteen other forms appear in the literature in other than unsupported lists identified erroneously for the most part with some of the twenty-two named species. Of the twenty-one specific names six are applied to forms that are inadequately described and either not figured at all or so poorly figured as to be entirely unrecognizable. As the types of nearly if not quite all of them are known to be lost or destroyed and as it should be obvious that topotypes are of little value in such a group there can be no good purpose in retaining such names in the literature. Any attempt to use them can only

confound confusion. These are *Chemnitzia attenuata* Stevens, *C. swalloviana* Shumard. *C. parva* Cox, *Loxonema plebium* Herrick, *L. plenum* Herrick, *L. plicatum* Whitfield. The remaining sixteen names are applied to forms which are better described and more adequately figured though there is still much to be desired in both respects. Of these sixteen, two, *Loxonema rugosum* Meek and Worthen and *Zygopleura affinis* Girty, are placed in the synonomy of *Loxonema scitulum* Meek and Worthen. Furthermore types can possibly be found for most of them. The same can be said for many of the forms identified with previously named species, although in the case of both the latter two classes identification may be very difficult without the types, as the various authors seem to have been prone to describe as of specific value characters that are of generic or subgeneric value only. For instance the fact that a *Pseudozygopleura* has transverse ribs hardly serves to differentiate it from other species nor does the fact that the ribs tend to form (or not to form) vertical rows have specific value. They no doubt appeared to be significant characters to an author with only a few specimens of one or two forms before him, but as a matter of fact both characters are typical of most of the members of a genus, not of any one species and they tend to find greater or less degrees of expression in many species. Nevertheless with the aid of the figures one should be able to discover at least what most of the forms are not, even if it is difficult to tell just what they are. Again it seems not to have been realized what a great number of species there are. Some fifty-six are described here and these are unquestionably not the complete representation from a narrow stratigraphic zone. There must be hundreds of species in the American Pennsylvanian and Permian. I have been able to identify only two of these fifty-six with any described forms. Speaking from the point of view of a stratigraphic paleontologist a synonym is a far less reprehensible error than a homonym. It seems more important that the stratigraphic range of two forms is not erroneously extended through misidentification than that the indices and bibliographies be saved the expense of printing a possibly superfluous name. And yet, short of the almost impossible task of examining scattered and possibly non-existent holotypes, I have made every effort to use the names in the literature. The fourteen names of Pennsylvanian species that seem reasonably well founded are as follows: *Loxonema semicostatum* Meek [=*Pseudozygopleura* (*Pseudozygopleura*) *semicostatum* Meek], *L. scitulum* Meek and Worthen [=*P.* (*P.*) *scitula* (M. & W.)], *L. multicostatum* Meek and Worthen [=*P.* (*P.*) *multicostata* (M. & W.)], *L. peoriense* Worthen [=*P.* (*P.*) *peoriensis* (Worthen)], *L. bellum* Walcott [=*P.* (*P.*) *bella* (Walcott)], *Zygopleura nana* Girty

[=*P.* (*P.*) *nana* (Girty)], *Z. teres* Girty [=*P.* (*P.*) *teres* (Girty)], *Z. nodosa* Girty [=*P.* (*Stephanozyga*) *nodosa* (Girty)], *Hemizyga dubia* Girty [=*Hemizyga* (*Plocezyga*) *dubia* Girty], *H. elegans* Girty [=*H.* (*Hemizyga*) *elegans* Girty], *H. grandicostata* Girty [=*H.* (*H.*) *grandicostata* Girty], *Aclisina ? cancellata* Mark [=*H.* (*H. ?*) *cancellata* (Mark)], *A. ? costata* Mark [=*H.* (*Plocezyga ?*) *costata* (Mark)], *A. ? ornata* Mark [=*H.* (*P. ?*) *ornata* (Mark)].

It is desirable to offer some statistics bearing on the stratigraphic and generic distribution of the species to be described here. Four hundred and sixty-eight specimens have been specifically identified. The specimens, mostly of very small species, have been compared and recompared under a good binocular miscroscope. In addition to the identified specimens, a comparable number have been studied and laid aside because poor preservation or immaturity precluded specific identification, although many of the latter were exceedingly valuable in the study of ontogeny.

Of the 468 identified specimens, 5 representing three species are from the lower Fort Scott limestone, 15 representing eight species from the base of the Pawnee limestone and the remaining 448 specimens representing fifty-four species from the top of the Labette shale. From the marine phase of the Bevier cycle I have a number of unidentifiable specimens which are not considered. From the "Chaetetes" limestone and upper Fort Scott limestone I have none. This tremendous discrepancy of numbers of species at different horizons does not necessarily imply similar differences in the abundance of forms living at the time of deposition in the area. Conditions of preservation and facility of collecting account for most of it. Fossils such as these are very difficult to collect from hard limestone and are rarely identifiable when so collected. The material from the top of the Labette was collected entirely by washing large quantities of the shale from a single good exposure containing fossils undamaged by weathering and preserved so that they could be freed from the matrix with little or no damage.

An outstanding feature of the statistical studies (see tabulation below) is that fifty-five species of several closely related stocks are shown to have been collected from the narrow stratigraphic zone represented in the top of the Labette shale and the base of the Pawnee limestone, the earlier sediments of the marine phase of a single sedimentary cycle (17). Of these all but one were found at a single locality from which alone most of them are recorded. They seem, superficially, at least, to have been living at the same time, under the same ecological conditions at the same place;—a most unusual occurrence if it is true. But let us look a little

closer. These fifty-five species are divided here into nine racial stocks of which eight occur in this single locality and zone. This reduces the figures somewhat, yet thirty-two species represented by 254 specimens are referred to a single stock, the subgenus, *Pseudozygopleura*, in the strict sense.

Examining more critically the detailed stratigraphy of this 4-foot zone, we find just beneath it a thin but recognizable underclay which is topped by a thin carbonaceous smut zone. These, according to the hypothesis recently proposed by J. Marvin Weller (17) represent a subaerially weathered soil with humus at the top. Directly above this lies the marine zone in question. It is lithologically a shale and on that basis is included in the underlying lithological unit, the Labette, but from a faunal and zonal point of view it should be included with the overlying Pawnee limestone; indeed it is the more argillaceous sediment of the earlier part of the marine phase of the Pawnee sedimentary cycle. Next above the coal smut is about two feet of somewhat calcareous shale of a strong reddish brown color with local green splotches. This red zone is here designated as Zone R. Above this and separating it from the next fossiliferous zone is about a foot of unfossiliferous shaly material concerning the nature and origin of which there is considerable doubt. It is suspected that it may be a bentonite bed but investigation of this question is not completed, so for present purposes it will be sufficient to note that it contains no fossils and separates the very fossiliferous Zone R from the second fossiliferous zone above. This latter is a highly calcareous green shale, here designated as Zone G, that grades without sharp lithological break into the overlying Pawnee limestone. (See Fig. 1.) Thus the 4-foot zone in question is sharply divided into two sub-zones. These sub-zones both carry faunules that are conspicuously molluscan and which in a broad way are similar. And yet there are many marked differences in details in nearly all of the fossil groups represented.

All of the thirty-two species of Pseudozygopleurae were present in the two subzones of this one 4-foot zone at a single locality Owing to local slumping at the outcrop it was not at first recognized that the zone was divisible and all the earlier collections, a very considerable part of the total, were made without keeping the faunules of the two subzones separate. Later when the details of the stratigraphy were better understood, other collections were made in which the faunules of the subzones were held and studied apart. Twenty-four species (153 specimens) of *Pseudozygopleura* (*ss*) were represented in the earlier collections, mixed as to these two subzones and twenty (87 specimens) in the later collection. The earlier collections contained thirteen species that were not

represented in the later collection. And these again contained nine species not represented in the former. Of these twenty species in the later collection only four are common to the two zones, nine are confined to Zone R and seven to Zone G. Then, assuming that the same ratio would hold for the thirty-two species known from both zones at the one locality, there would be about seven species in common to the two, about thirteen from Zone R and twelve from Zone G alone, a total of twenty species in the first and nineteen in the second. If these twenty or so species of the same genus actually lived together at the same time, at the same place and under the same ecological conditions, it would seem unusual and would tend to raise questions as to the validity of the species discriminated. And yet the fact that their remains are to-day found together need not imply that they actually lived together under the same ecological conditions. To cite an illustration, there are found associated together on the beaches and shallow shoreward bottoms of Long Island Sound the shells of four species of *Littorina* and three of *Crepidula*. If one collects these as he must perforce collect fossils, it would be only natural to conclude that the four species of one genus and the three of the other lived together under the same ecological conditions, which is not the case. They do live at the same time and, in a general way, at the same place so that their shells may be associated after death but each is found on study of living specimens to be adapted to some special phase of the same general environment.

Another case in point is that shown by the Turbonillae of the Pacific Coast of North America and presumably other areas as well. Dall and Bartsch (18, a, b) have recognized no less than one hundred and sixty-three species of these interesting homeomorphs of both *Zygopleura* and *Pseudozygopleura* in the area studied, seventy-seven of which are to be found in a single province, the Californic. Twenty-five of the latter are referred to the subgenus *Pyrgiscus*. Many living genera of gastropods seem to show tremendous specific integration and adaptation to minute differences of ecology such as may exist contemporaneously in closely adjacent and restricted areas or zones, each of which may supply dead shells to the other.

And again, there is a time difference between the different microzones in even a 6-inch subzone. Who can tell how often various minute shades of ecological differences may have shifted back and forth across any given spot during the deposition of the material making up such a subzone, bringing into that locality with each shift a change in the specific content of the local faunule, and leaving in the thin zone of sediments there accumulated, remains of each faunule inextricably mixed.

On the whole the apparent association of twenty or so species of the same genus need not lead us to conclude that they can not be valid and distinct species.

It might be suggested that some at least of the species described are hybrids. To this I can only say that such may be the case but that I am entirely without evidence supporting such a supposition. In fact proof of such a condition with only fossil specimens to work with seems virtually impossible. Grueneberg (19) has presented a speculation suggesting hybridization to account for a somewhat similar integration in the case of some Devonian Murchisoniae and while his conclusions are interesting and quite plausible they entirely lack the numerical proof required to give them weight.

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To Professor Carl O. Dunbar of Yale University I am especially indebted. He not only critically read my manuscript but from time to time has made many valuable suggestions. To my friend Doctor J. Marvin Weller of the Illinois State Geological Survey I am indebted for assistance in the correlations between the St. Louis Pennsylvanian outlier and the general Illinois section as shown in text figure 1. The correlations between the former and the beds exposed in the bluffs of Mississippi River in St. Clair County, Illinois, are my own, but in the placement of the latter in the Illinois section I am largely indebted to his suggestions, some of them still somewhat tentative. Doctor Weller has also accompanied me in the field in the St. Louis district a number of times, and on a rapid reconnaissance across Missouri into eastern Kansas. Professor W. Courtney Werner, Mr. David N. Delo and other friends at Washington University, St. Louis, have at times assisted in collecting fossils. Mr. Delo is especially to be thanked in this respect. I am also indebted to Professor Raymond C. Moore, of the University of Kansas, for valuable assistance in preparing the manuscript and plates for publication.

FOREWORD TO DESCRIPTION OF SPECIES

Before undertaking the description of species it may be well to explain the method of description used. Because of the large number of species to be described every effort has been made to secure brevity, it is hoped without sacrificing accuracy of detail. To this end and to facilitate comparison, all the descriptions are put into a standard form except for a few to which it was obviously not well adapted. Measurements are tabulated at the beginning of each description and any so tabulated will not be mentioned again.

The nuclear whorls are not described except where they may vary markedly from the typical. It is to be understood in all cases where no mention is made of them that they conform in their general characters to the typical nucleus of the sub-family as described. In the case of any species where no nucleus sufficiently well preserved to indicate its character has been observed such fact is specifically stated.

The terms "shouldered" and "pendant" as applied to the whorl profile, and "sinuosity" and "obliquity" as applied to the course of the costae, should be easily understood, although some of them are I believe new in this application. The obliquity of the costae is said to be normal when its general course passes downward and forward from the upper suture, as in the typical genus. It is said to be reversed when the opposite condition exists, as in *Hemizyga*. The term "adpressed" is used to indicate that the whorls are pressed at their upper margins against the whorl above.

The spiral angles were in all cases measured on photographs of the holotype or selected plesiotype. The "apical angle over all" is the angle between two straight lines drawn from the apex (the position of which is estimated if the apex is lacking) tangent to the sides of the last whorl. The similar angle for the neanic whorls is arrived at in the same manner. The "pleural angle" is the angle formed by two lines tangent to the last two whorls and represents the mature condition of the spire.

In general it may be said that, unless otherwise stated, the measurements were taken from the principal type specimen, often checked as typical by comparisons with measurements made on paratypes; but that the general description involved consideration of all the specimens assigned to a given species.

With others I have felt the need of a term to designate the principal or typical specimen among several plesiotypes. For this purpose I am coining the term *cyrioplesiotype* derived from the Greek κυριος (chief, principal) and the term plesiotype already in use.

Concerning the plates it is to be noted that due to the great differences of size among different species, various scales of magnification have been used so that many forms of very different size will appear practically the same in size on the plate. It is hoped that the natural size figures placed beside each magnified figure will help the student to visualize the relative size of the species sufficiently well without sacrificing the desired detail to be secured by magnification.

STATISTICAL TABULATION OF THE PSEUDOZYGOPLEURINAE

The figures refer to the number of specimens.

Genus	Subgenus	Species	Lower Fort Scott limestone	Labette Shale			Pawnee limestone	Total
				Old Collection	Zone R	Zone G		
Pseudozygopleura	*Pseudozygopleura*	*semicostata*	..	19	9	10	..	38
		croneisi	..	7	13	2	..	22
		scitula	2	8	2	8	3	23
		sp.	..	..	..	..	1	1
		williamsi	..	1	..	2	1	4
		trochus	..	..	..	2	..	2
		rothi	..	..	1	..	..	1
		girtyi	..	3	..	..	5	8
		conica	..	2	..	..	2	4
		condrai	..	3	..	..	..	3
		plummeri	..	3	..	1	..	4
		werneri	..	1	..	..	..	1
		sinuosior	..	6	2	..	..	8
		pulchra	..	..	..	1	..	1
		moorei	..	2	1	..	..	3
		terebra	..	..	..	1	..	1
		restis	..	..	1	..	..	1
		pagoda	..	1	..	..	..	1
		schucherti	..	1	..	..	..	1
		pluricostata	..	2	..	..	1	3
		deloi	..	..	1	..	..	1
		nigra	..	4	..	..	..	4
		pupa	..	..	2	..	..	2
		kellettae	..	27	4	3	..	34
		recticostata	..	4	..	..	..	4
		inornata	..	4	6	..	..	10
		obtusicacuminis	..	..	..	4	..	4
		assertonsoris	..	6	..	..	..	6
		tenuivirga	..	19	7	..	1	27
		leveneae	..	25	2	..	..	27
		acuminata	..	2	..	..	..	2
		praeacuta	..	2	..	..	..	2
		perversa	..	1	..	2	..	3
		Totals	2	153	51	36	14	256
	Pyrgozyga	*cylindrata*	..	2	1	4	1	8
		macra	..	17	3	1	..	21
		dunbari	..	23	4	8	..	35
		marvinwelleri	1	1	2	1	..	5
		funis	..	1	..	..	..	1
		warthini	..	1	..	..	..	1
		Totals	1	45	10	14	1	71
	Stephanozyga	*subnodosa*	2	..	..	..	..	2
	Leptozyga	*minuta*	..	8	..	14	..	22
	Totals		5	206	61	64	15	351

Genus	Subgenus	Species	Lower Fort Scott limestone	Labette Shale			Pawnee limestone	Total
				Old Collection	Zone R	Zone G		
Helminthozyga	.....	*vermiculus*	..	..	..	26	..	26
Hemizyga	*Plocezyga*	*corona*	..	1	..	1	..	2
		angularis	..	11	..	11	..	22
		abolescens	..	..	..	1	..	1
		tenuilirata	..	7	..	..	..	7
		tenuis	..	..	1	..	..	1
		percostata	..	..	..	10	..	10
		Totals	..	19	1	23	..	43
	Hemizyga	*inflata*	..	1	..	..	..	1
		illinecta	..	..	..	2	..	2
		corpulentissima	..	2	..	2	..	4
		corbis	..	2	1	..	..	2
		Totals	..	5	1	4	..	10
	Hyphantozyga	*gracilis*	..	1	..	..	..	1
		sp.	..	1	..	..	..	1
		Totals	..	2	..	..	..	2
	Totals		..	26	2	27	..	55
Cyclozyga	.....	*mirabilis*	..	4	8	20	..	32
		carinata	..	..	..	4	..	4
	Totals		..	4	8	24	..	36
Grand t't'ls			5	236	71	141	15	468

RECAPITULATION

		Species		Specimens	
Pseudozygopleura	*Pseudozygopleura*	33		256	
	Pyrgozyga	6		71	
	Stephanozyga	1		2	
	Leptozyga	1	41	22	351
Helminthozyga			1		26
Hemizyga	*Plocezyga*	6		43	
	Hemizyga	4		10	
	Hyphantozyga	2	12	2	55
Cyclozyga			2		36
			56		468

		Species	*Specimens*
Species of	20 specimens or more	12	329
Species of	10 to 19 specimens	2	20
Species of	5 to 9 specimens	6	42
Species of	2 to 4 specimens	20	61
Species of	1 specimen only	16	16
		56	468

KEY TO THE GENERA AND SUBGENERA OF THE PENNSYLVANIAN PSEUDOZYGOPLEURINAE

All genera and subgenera carry the characteristic nucleus of the subfamily.

A¹ Post-nuclear whorls bear transverse ribs, or all whorls may be without ornamentation.

B¹ No revolving ornamentation in addition to transverse ribs. Base smooth. Costae with normal obliquity.

C¹ Tightly coiled, base imperforate — Genus *PSEUDOZYGOPLEURA*

D¹ Transverse ribs rather coarse and passing completely from suture to suture, or phylogerontically lacking on some or all whorls.

E¹ Whorl profile not shouldered, columella somewhat arcuate. — Subgenus *Pseudozygopleura* (*ss*)

E² Whorl profile shouldered, columella straight. — Subgenus *Pyrgozyga*

D² Transverse ribs coarse but more or less distinctly limited to the middle of the whorl and node-like. — Subgenus *Stephanozyga*

D³ Transverse ribs very fine, shell minute with rather narrower aperture and more arcuate columella than typical. — Subgenus *Leptozyga*

C² Uncoiled at later stages. May pass through umbilicate stage. — Genus *HELMINTHOZYGA*

B² With revolving ornamentation in addition to transverse ribs. Costae with reversed obliquity. — Genus *HEMIZYGA*

C¹ Transverse ribs coarse and confined to the sides of the whorls. — Subgenus *Plocezyga*

C² Transverse ribs on both sides and base of the whorls.

D¹ Transverse ribs strong as compared with revolving lirae. Subgenus *Hemizyga* (*ss*)

D² Transverse ribs and revolving ribs of about the same strength. Subgenus *Hyphantozyga*

A² Post-nuclear whorls bear revolving ridges only. Genus *CYCLOZYGA*

NOTE. No provision is here made for forms with transverse ribs alone appearing both on the sides and the base of the whorls, or for such as have the transverse ribs near the upper suture only. Such forms are described from Devonian and Mississippian rocks and may yet be found in Pennsylvanian and Permian strata. They are now referred to *Loxonema* or *Zygopleura*, probably wrongly in both cases. They can not, however, be referred confidently to the Pseudozygopleurinae until the nature of their nuclei is known. If they do eventually prove to belong in this group they may well form subgenera of *Pseudozygopleura*.

DESCRIPTION OF SPECIES

FAMILY LOXONEMATIDAE KOKEN

SUBFAMILY PSEUDOZYGOPLEURINAE KNIGHT

GENUS PSEUDOZYGOPLEURA KNIGHT, N. G.

SUBGENUS PSEUDOZYGOPLEURA KNIGHT, N. SUBG.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) SEMICOSTATA (MEEK)

Plate 1, figures 1a-e

Loxonema attenuata var. *semicostata* MEEK, *1871*, Acad. Nat. Sci. Phila., Proc., p. 174. Shale over the coal bed at Danville, Illinois.

Loxonema semicostata MEEK AND WORTHEN, *1873*, Ill. Geol. Survey, Vol. 5, p. 596, Pl. 29, figs. 2a, 2b. Roof of Danville coal, Danville, Illinois.

Not *Loxonema semicostatum* DE KONINCK, *1881*.

	A	*B*	*C*
Number of whorls	13	15[a]	14
Height	6.0	8.1[a]	6.2 mm.
Greatest width	1.58	2.2	1.83 mm.
Apical angle, over all	20°	18½°[a]	19½°
Apical angle, neanic	28°	40°	35°
Pleural angle	11°	14°	14½°
Ratio of height to width	3.8	3.7[a]	3.4
Ratio of height of body whorl to total	.36	.32[a]	.31
Number of costae, seventh whorl	19		

[a]Estimated on the assumption that four apical whorls are missing.

The measurements designated A were taken from the cyrioplesiotype, those under B and C from plesiotypes representing approximately the extremes in variation.

Elongate conical; sides nearly straight, generally slightly convex at neanic stages; whorl profile gently arched and pendant; sutures shallow;

aperture sub-oval; base rounded or on some specimens very slightly flattened.

There is a strong tendency in this species toward suppression of the costae. On most specimens traces of costae are observed only on the first and perhaps the second post-nepionic whorls. One specimen, the cyrioplesiotype, is costate on six post-nepionic whorls, that is from the 4th through the 9th inclusive. The costae are typically low and rounded with a gentle sinuosity and moderate to well marked obliquity. Two specimens preserve traces of coloration which consists of a single, rather narrow revolving dark band at about mid-whorl-face.

The pendant whorl profile and partially to wholly suppressed costae on this species are characteristic. *Pseudozygopleura peoriensis* (Worthen) seems to be almost identical in these characters but is a considerably larger shell whorl for whorl, a feature that is considered to have good specific value. *P. praeacuta* Knight has a flat whorl profile and base.

Top of the Labette shale, Locality 43, 19 specimens, of which 10 are from Zone G and 9 from Zone R. Cyrioplesiotype, Yale Peabody Museum No. 12951.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) CRONEISI KNIGHT, N. SP.
Plate 1, figure 3

Number of whorls	13[a]
Height	7.8 mm.[a]
Greatest width	2.25 mm.
Apical angle, over all	20°[a]
Apical angle, neanic	29°[a]
Pleural angle	14°
Ratio of height to width	3.45[a]
Ratio of height of body whorl to total	.42[a]
Number of costae, seventh whorl	15
Number of costae, twelfth whorl	19

[a]Estimated on the assumption that 3 apical whorls are missing from the holotype.

Acutely high-spired; sides slightly convex at neanic stages, straight at ephebic; whorl profile gently arched, pendant and adpressed; sutures shallow; whorls about 55 percent as high as wide; aperture auriform; base rounded.

Transverse costae fairly strong, with slight sinuosity, and obliquity. The interspaces, about as wide as the costae. The costae arise abruptly, but not at full height, at the upper suture, increase in height slightly as they pass down over the face of the whorl and die away rather abruptly just below the lower line of suture. On three of the specimens referred to this species the costae become irregular at about the eleventh whorl;

that is to say, at this point the costae become small and crowded for a whorl or two, or, as on one specimen, the eleventh whorl is almost entirely without costae although on the twelfth they are typically developed. It is difficult to say whether this tendency should be regarded as a specific character. Traces of coloration are preserved on the holotype. The shell seems to have been dark except for a narrow band just below the upper suture and for the crests of the costae.

This species suggests *P. semicostata* more than any other and yet it is a larger, coarser shell and is typically costate to the final whorl. It is very considerably smaller than *P. scitula* and does not have the highly sinuous and oblique costae of *P. sinuosior*. The name is in honor of Professor Carey G. Croneis of the University of Chicago.

Top of the Labette shale, Locality 43, 22 specimens, of which 13 are from Zone R, 2 from Zone G, with 7 unallocated. Holotype, Yale Peabody Museum, No. 12952.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) SCITULA (MEEK AND WORTHEN)

Plate 1, figures 2a-c

Loxonema scitula MEEK AND WORTHEN, *1860*, Acad. Nat. Sci., Phila., Proc., p. 464. Lower Coal Measures, Hodges Creek, Macoupin County, Illinois; *1866*, Ill. Geol. Survey, Vol. 2, p. 377, Pl. 31, figs. 10a-c.

Loxonema rugosa MEEK AND WORTHEN, *1860*, Acad. Nat. Sci., Phila., Proc., p. 465, Upper Coal Measures, Springfield, Illinois; *1866*, Ill. Geol. Survey, Vol. 2, p. 378. Pl. 31, figs. 11a-c. Upper Coal Measures, Springfield, Illinois.

Zygopleura rogosa GIRTY, *1915*, U. S. Geol. Survey, Bull. 544, p. 183, Pl. 25, figs. 1, 1a. Wewoka formation, Wewoka quadrangle, Oklahoma.

Zygopleura affinis GIRTY, *1915*, Mo. Bur. Geol. & Mines, Vol. 13, 2d ser., p. 359, Pl. 32, figs. 6-6b. Cherokee shale, Garland, Henry County, Missouri.

	A	*B*	*C*
Number of whorls	15[a]	15[b]	15
Height	27½[a]	26[b]	28 mm.
Greatest width	8	8	9 mm.
Apical angle, over all	21°[a]	21°[b]	24°
Apical angle, neanic	21°[a]	?	28°
Pleural angle	20°	22½°	23°
Ratio of height to width	3.4[a]	3.3[b]	3.1
Ratio of height of body whorl to total	.38[a]	.39[b]	.43
Number of costae, eighth whorl	17	..	16+
Number of costae, fourteenth whorl	18	20	24+

[a]Estimated on the assumption that 7 apical whorls are missing.

[b]Estimated on the assumption that 9 apical whorls are missing.

The measurements labeled A were taken from the cyrioplesiotype, those labeled B from another mature plesiotype, both from the Labette

shale, while those labeled C were taken from a complete specimen from the lower Fort Scott limestone.

Elongate, conical; sides straight to very slightly concave; whorl profile gently arched and somewhat pendant, distinctly adpressed; whorls about half as high as wide; sutures moderately deep; aperture auriform; base rounded on the adult but rather flattened on the earlier whorls, which gives the latter a somewhat pagoda-like appearance.

The transverse costae are rather sharp and approximately equal in width to their interspaces. They have considerable sinuosity and moderate obliquity, particularly on the later whorls. They arise quite gradually on the adpressed band and pass across the face of the whorl at gradually increasing height, till just below the middle of the whorl face where they begin to decrease in height a little more rapidly than they arose, and die out just below the lower line of suture. A single specimen referable to this species preserves traces of coloration. There seem to have been five alternating revolving bands of darker and lighter color. The adpressed band of the whorl is light, followed by a dark band passing around the upper-middle whorl face. The lower whorl face is light. A rather dark band passes around just below the lower line of suture and the central part of the base is again light.

It is only after considerable study that I have been convinced that my specimens which seemingly fell into five groups were not only conspecific among themselves but with the specimens described by Meek and Worthen as *Loxonema scitulum* and *L. rugosum*, as well as with that identified by Girty with the latter and that described by him as *Zygopleura affinis*. The difficulty lay in the fact that the earlier whorls seem to have a flatter base than the later ones so that a specimen in early maturity presents an appearance sufficiently different to justify seemingly specific differentiation. I am convinced that both Meek and Worthen, and Girty were misled by this character in separating first *L. rugosa* from *L. scitula*, and *Z. affinis* from the former. Meek and Worthen, indeed, were far from certain that their two forms were specifically different and placed their chief reliance on the fact that the costae in the form called *rugosa* seem to be regularly disposed each one below a corresponding costa on the preceding whorl, while on the form called *scitula* they alternated. If my observations mean anything, this character has no specific value whatever and is merely a tendency, probably induced by mechanical considerations, which is the normal condition in the genus but from which individual departures are very common. I have a number of specimens of different species that show both conditions on the same

shell. There is a very considerable discrepancy in my whorl counts and those of Meek and Worthen and Girty. These authors were dealing with specimens that lacked the apical whorls, the minuteness of which they seem not to have guessed, and they either failed to take the lost volutions into consideration or underestimated their number. My similarly incomplete specimens of like growth stages seem to match theirs whorl for whorl.

The specimens identified by C. A. White (1m) and by Plummer and Moore (1k) with *Loxonema rugosum* Meek and Worthen I would exclude from the synonomy.

P. scitula differs from *P. condrai* by its considerably larger size and robust form, from *P. sinuosior* in its larger size and stronger and less sinuate costae. *P. croneisi* is a smaller and finer shell.

Lower Fort Scott limestone, Locality 10, 1 specimen; Locality 21, 1 specimen. Top of the Labette shale, Locality 43, 18 specimens, of which 8 are from Zone G, 2 from Zone R, and 8 unallocated. Base of the Pawnee limestone, Locality 6, 3 specimens. Cyrioplesiotype, Yale Peabody Museum, No. 12953.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) SP. A.
Plate 1, figure 4

Greatest width, 5.0 mm. Pleural angle, 23°. Number of costae, 14. Due to the fragmentary condition of the only specimen no other measurements were taken.

The specimen consists of the final two and one-half whorls. Sides rather flat; sutures quite shallow; whorl profile adpressed at the upper suture and markedly pendant; base flatly arched; aperture sub-rhomboidal. The ornamentation consists of rather strong sharp costae which do not appear as wide as the interspaces. These number 14 on the next to last volution. The costae arise very gradually on the adpressed band a slight distance below the suture and reach their maximum height about three-quarters of the way down the side, from which point they descend more rapidly to the line of suture where they become obsolete. No evidence of coloration is preserved.

The strong, sharp, pendant costae serve to distinguish this shell from others known to me, yet it does not seem advisable to give it a specific name when knowledge of the apical part is lacking.

Base of the Pawnee limestone, Locality 6, 1 specimen. Yale Peabody Museum, No. 12954.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) WILLIAMSI KNIGHT N. SP.
Plate 1, figures 5a-c

Number of whorls	11[a]
Height	9.5 mm.[a]
Greatest width	3.3 mm.
Apical angle, over all	28°[a]
Apical angle, neanic	39°
Pleural angle	21°
Ratio of height to width	2.86
Ratio of height of body whorl to total	.43

[a]Estimated on the assumption that three apical whorls are lost from the holotype.

Elongate, conical; sides straight to very slightly convex; whorl profile gently arched, adpressed, pendant; whorls about half as high as wide; aperture sub-quadrate; base rather flatly rounded. The nucleus has not been seen.

Except for very obscure and rather fine transverse costae on the neanic volutions of some specimens and a few very fine growth-lines there is no post-nuclear ornamentation at all. The surface is smooth, almost polished. No traces of coloration are observed.

This species has so close a superficial resemblance to the *Soleniscus-Sphaerodoma* group of shells, particularly to such as have the columellar fold only slightly developed, that for some time I tentatively associated it with them. Yet while the nucleus is missing from all of my specimens and final confirmation of the present generic assignment must await its discovery, the general form, typical reflexed inner lip and particularly the faint traces of costation on the earlier whorls of the holotype as well as the lack of truly distinctive soleniscoid characters have served to convince me that it is a true non-costate *Pseudozygopleura*. This species is larger, relatively wider than any other smooth members of the genus except perhaps *P. inornata* which has a very different form.

It is not unlike "*Loxonema bella*" Walcott as figured by the author, but is smaller and has a wider apical angle. It differs from the Wewoka shell referred by Girty to Walcott's species in being considerably smaller, and in not having the flattened volutions of that species. It differs in much the same way from *Orthonema conicum* Meek and Worthen. The name is for Professor James S. Williams of the University of Missouri.

Top of the Labette shale, Locality 43, 4 specimens, of which one is known to be from Zone R and two from Zone G. Base of the Pawnee limestone, Locality 6, 1 specimen. Holotype, Yale Peabody Museum, No. 12955.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) TROCHUS KNIGHT, N. SP.
Plate 38, figure 7

Number of whorls	11[a]
Height	9.5 mm.[a]
Greatest width	4.6 mm.
Apical angle, over all	34°[a]
Apical angle, neanic	44°[a]
Pleural angle	31°
Ratio of height to width	2.0[a]
Ratio of height of body whorl to total	.53[a]
No post-nepionic costae	

[a]Estimated on the assumption that three apical whorls are missing.

Top-shaped; sides straight; whorl profile almost flat; sutures not impressed; base flatly rounded; aperture sub-quadrate. The nucleus is missing from the holotype but an immature specimen of six whorls which seems to be conspecific with the holotype shows a typical pseudozygopleuroid nucleus.

Shell seems to have been totally without sculpture of any sort at all post-nepionic stages, not even lines of growth being visible on the smooth, almost polished surface of the holotype. Hence it is impossible to learn the course of the outer lip as that feature is broken away and there are no growth-lines to serve as guides. No traces of coloration are to be seen.

The top-like form of this shell seems to characterize it so well as to make comparisons unnecessary.

Top of the Labette shale (Zone G), Locality 43, two specimens, one of them juvenile. Holotype, Yale Peabody Museum, No. 12956.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) ROTHI KNIGHT, N. SP.
Plate 1, figure 8

Number of whorls	10
Height	5.08 mm.
Greatest width	2.25 mm.
Apical angle, over all	36°
Apical angle, neanic	43°
Pleural angle	34°
Ratio of height to width	2.24
Ratio of height of body whorl to total	.56
Number of costae, tenth whorl	40+

Conical; straight sides; whorl profile rather flat; suture quite shallow; aperture sub-quadrate; base flatly rounded.

The transverse costae are low and fine but widely spaced. The interspaces appear three to four times as wide as the costae. The costae have slight normal sinuosity and obliquity. The base is smooth. No traces of color have been seen.

This species has much the form of *P. trochus*, but is considerably smaller and is further distinguished by the presence of costae. The conical form and fine, widely spaced costae serve to distinguish it from all other species known to me. The name is in honor of Mr. Robert I. Roth of the Indian Territory Illimunating Oil Company.

A single specimen was obtained from the top of the Labette shale (Zone G) at Locality 43. Holotype, Yale Peabody Museum, No. 12957.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) GIRTYI KNIGHT, N. SP.
Plate 1, figures 6a-b

Number of whorls	13[a]
Height	12.6 mm.[a]
Greatest width	4 mm.
Apical angle, over all	23°[a]
Apical angle, neanic	36°[a]
Pleural angle	16½°
Ratio of height to width	3.2[a]
Ratio of height of body whorl to total	.39[a]
Number of costae, sixth whorl	13
Number of costae, twelfth whorl	15

[a]Estimated on the assumption that 3 apical whorls are missing from the holotype.

Elongate conical; sides straight or very slightly convex; whorl profile gently and evenly arched, slightly adpressed; sutures shallow; aperture sub-quadrate; base flattened. Nucleus not seen.

Transverse costae strong, and about equal to interspaces. They arise abruptly at the upper suture and passing across the whorl face at uneven height, die away just below the lower line of suture. They have little sinuosity or obliquity.

P. girtyi is characterized by its strong, regular, only slightly sinuous or oblique costae and elongate conical, nearly straight sided form. It is relatively more elongate than *P. scitula* and in that species the adpressed sutures are much more marked. The name is in honor of Dr. George H. Girty of the United States Geological Survey.

Top of the Labette shale, Locality 43, three specimens. Base of the Pawnee limestone, Locality 6, five specimens. Holotype, Yale Peabody Museum, No. 12958.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) CONICA KNIGHT, N. SP.
Plate 2, figures 1a-b

Number of whorls	11[a]
Height	4.5 mm.[a]
Greatest width	2.12 mm.
Apical angle, over all	27½°[a]
Apical angle, neanic	22°[a]
Pleural angle	22°
Ratio of height to width	2.12[a]
Ratio of height of body whorl to total	.45[a]
Number of costae, tenth whorl	20

[a]Estimated on the assumption that 5 apical whorls are missing from the holotype.

Elongate, conical; sides straight; whorl profile, very gently arched and slightly pendant, almost flat, slightly adpressed; sutures very shallow; whorls very low, the tenth on the holotype being only about one-third as high as wide; aperture sub-quadrate; base somewhat flatly rounded. Nucleus not seen.

Transverse costae moderately strong, equal to or a little wider than their interspaces, with little sinuosity but a moderate amount of obliquity. They arise rather abruptly at the upper suture and, passing across the whorl face at an even height, die out just below the line of suture. No traces of coloration are preserved.

This shell is distinctly characterized by its conical shape, flat sides, its whorl profile, its low whorls and flattish base. Since none of my specimens show crowding of the costae near the aperture they may not be fully mature. Nevertheless the addition of more volutions would not obscure the characters noted above.

Base of the Pawnee limestone, Locality 6, two specimens (including the holotype). Top of the Labette shale, Locality 43, two specimens. Holotype, Yale Peabody Museum, No. 12959.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) CONDRAI KNIGHT, N. SP.
Plate 1, figure 9

Number of costae	12[a]
Height	10.7 mm.[a]
Greatest width	2.9 mm.
Apical angle, over all	20½°[a]
Apical angle, neanic	?
Pleural angle	15°
Ratio of height to width	3.7[a]
Ratio of height of body whorl to total	.42[a]
Number of costae, seventh whorl	17
Number of costae, eleventh whorl	18

[a]Estimated on the assumption that 6 apical whorls are lost from the holotype.

Attenuate-conical; sides nearly straight; whorl profile smoothly rounded, slightly adpressed; sutures of moderate depth; whorls rather high, being about 60 per cent as high as wide; aperture sub-quadrate; base flatly rounded. Nucleus not seen.

Transverse costae, rather low, rounded, seemingly a little wider than their interspaces. The costae rise gradually from the upper suture, attaining their maximum in a short space, and, passing across the whorl face at an even height, they die out just below the lower line of suture. They are rather strongly sinuate but not notably oblique.

P. condrai resembles somewhat *P. plummeri* in general form but is a considerably larger, coarser shell, has relatively higher whorls and less oblique costae. It is smaller than *P. schucherti* and has fewer, broader costae and shallower sutures. When figures at different magnifications bringing about apparent agreement in size are compared, *P. condrai* seems much like *P. girtyi* but a side by side comparison immediately shows that they are distinct; *P. condrai* is much the smaller and more attenuate. The name is in honor of Doctor G. E. Condra, State Geologist of Nebraska.

Top of the Labette shale, Locality 43, three specimens. Holotype, Yale Peabody Museum, No. 12960.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PLUMMERI KNIGHT, N. SP.
Plate 1, figures 10a-b

Number of whorls	14[a]
Height	7.5 mm.[a]
Greatest width	2.2 mm.
Apical angle, over all	19°[a]
Apical angle, neanic	25°[a]
Pleural angle	12°
Ratio of height to width	3.4
Ratio of height of body whorl to total	.36
Number of costae, sixth whorl	16
Number of costae, thirteenth whorl	23

[a]Estimated on the assumption that three apical whorls are missing.

Attenuate, conical; sides very slightly convex; whorl profile rather sharply rounded, slightly pendant and adpressed; whorls about half as high as wide; aperture sub-quadrate; base flattened.

Transverse costae rather sharp, about equal to interspaces, only slightly sinuous but somewhat oblique. They arise at the upper suture, increase rapidly in height, reaching the maximum a little above the middle of the whorl face and die out just below the line of the lower suture. No traces of coloration have been seen.

P. plummeri resembles somewhat *P. condrai* but differs in that it is smaller, finer, has relatively lower whorls, and more numerous and more oblique costae. It is a smaller and finer shell than *P. scitula* (Meek and Worthen), The name is in honor of Mr. Frederick B. Plummer of the University of Texas.

Top of the Labette shale, Locality 43, four specimens of which one is from Zone G and the others unallocated. Holotype, Yale Peabody Museum, No. 12961.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) WERNERI KNIGHT, N. SP.
Plate 2, figure 2

Number of whorls	12?[a]
Height	12? mm.[a]
Greatest width	2.75 mm.
Apical angle, over all	16°?[a]
Apical angle, neanic	?
Pleural angle	10½°
Ratio of height to width	4.38[a]
Ratio of height of body whorl to total	.27[a]
Number of costae, eleventh whorl	20

[a]Estimated on the assumption that seven apical whorls are lost from the holotype.

High-spired and sub-cylindrical; whorl profile gently and evenly rounded; whorls quite high, nearly 70 per cent as high as wide; sutures shallow and very slightly adpressed; aperture auriform; base deeply rounded; nucleus not seen.

Transverse costae rather strong, with narrow interspaces, very little sinuosity or obliquity. They arise sharply at the upper suture, cross the whorl face at an even height, and die out just below the lower line of suture.

Since I have only one specimen of five and one-half whorls, the estimates involving factors depending on the lost whorls must be considered very tentative. This sub-cylindrical, very attenuated form with round whorls, rounded base and coarse costae hardly needs comparisons with any other species with which I am acquainted. The name is in honor of Professor W. Courtney Werner of Washington University, St. Louis, Missouri.

Top of the Labette shale, Locality 43, one specimen. Holotype, Yale Peabody Museum, No. 12962.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) SINUOSIOR KNIGHT, N. SP.
Plate 2, figure 3

Number of whorls	12 to 13
Height	8.25 mm.
Greatest width	2.75 mm.
Apical angle, over all	25°
Apical angle, neanic	34°
Pleural angle	20°
Ratio of height to width	3.00
Ratio of height of body whorl to total	.40
Number of costae, sixth whorl	17
Number of costae, eleventh whorl	27

Elongate-conical; sides straight, only very slightly convex at neanic stages; whorl profile gently arched, decidedly pendant, slightly adpressed; sutures shallow; aperture sub-quadrate; base flatly rounded.

Transverse costae numerous, low, narrow and rounded, about equal to their interspaces in width and notably sinuous and oblique. They rise abruptly at the upper suture, and, passing across the face of the whorl at an even height, die out just below the lower line of suture. No traces of coloration are preserved.

P. sinuosior is characterized by its oblique, sinuous costae in connection with its pendant whorl profile and sharply conical spire.

Top of the Labette shale, Locality 43, eight specimens of which two are from Zone R. Holotype, Yale Peabody Museum, No. 12963.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PULCHRA KNIGHT, N. SP.
Plate 2, figure 4

Number of whorls	13
Height	4.7 mm.
Greatest width	1.16 mm.
Apical angle, over all	17°
Apical angle, neanic	27°
Ratio of height to width	4.0
Ratio of height of body whorl to total	.31
Number of costae, twelfth whorl	33

Attenuate-conical; sides very gently convex; whorl profile gently arched and somewhat pendant, slightly adpressed; sutures shallow; base rather flatly rounded; aperture sub-quadrate.

Transverse costae low, rather fine and with distinct sinuosity and obliquity. The costae arise gradually at the upper suture and, passing across the whorl face at an even height, they die out just below the lower line of suture. No traces of coloration have been seen.

This small, fine and delicate species hardly needs comparison unless with *P. assertonsoris*. Its pendant whorl profile and numerous fine sinuous and oblique costae, however, serve to distinguish it at once.

I have a single specimen from the top of the Labette shale (Zone G) at Locality 43. Holotype, Yale Peabody Museum, No. 12964.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) MOOREI KNIGHT, N. SP.
Plate 2, figure 9

Number of whorls	12?[a]
Height	16 mm.?[a]
Greatest width	4.25 mm.
Apical angle, over all	18½°[a]
Apical angle, neanic	?
Pleural angle	14°
Ratio of height to width	8.75[a]
Ratio of height of body whorl to total	.33[a]
Number of costae, eleventh whorl	20

[a]Estimated on the assumption that 8 apical whorls are lost from the holotype.

High spired; sides straight at ephebic stages, neanic stages not observed; whorl profile evenly arched, slightly adpressed; sutures of moderate depth; aperture sub-quadrate; base somewhat flattened. Nucleus not observed.

Transverse costae moderately strong. They arise rather gradually at the upper suture, pass down over the face of the whorl, rising in height for the first half of the distance and thence losing height somewhat less rapidly until they dip inward to disappear just below the line of the lower suture. The costae are only slightly sinuous but show a fair amount of obliquity. No traces of coloration have been observed.

Comparing this species with *P. scitula* (Meek and Worthen) we find that it is notably more slender and that it is mature at about two-thirds the size of that form. It has less rounded whorls than *P. schucherti*, fewer stronger costae and a slight adpressed zone which is entirely lacking in the latter; it is decidedly more robust than *P. condrai* or *P. werneri*. The name is in honor of Professor Raymond C. Moore of the University of Kansas and State Geologist of Kansas.

From the top of the Labette shale at Locality 43, three specimens one of which is from Zone R. Holotype, Yale Peabody Museum, No. 12965.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) TEREBRA KNIGHT, N. SP.
Plate 2, figure 5

Number of whorls	14[a]
Height	6.1 mm.[a]
Greatest width	1.43 mm.
Apical angle, over all	13½°[a]
Apical angle, neanic	28°
Pleural angle	8½°
Ratio of height to width	4.6[a]
Ratio of height of body whorl to total	.28[a]
Number of costae, seventh whorl	21
Whorls 9 to 14 without costae	

[a]Estimated on the assumption that 2 apicals whorls are missing.

Sub-cylindrical; sides slightly convex at neanic, straight at ephebic stages; whorl profile very gently rounded, slightly pendant and adpressed; sutures quite shallow; base markedly flattened; aperture subquadrate. The nucleus has not been seen.

The first six or seven post-nepionic whorls carry transverse costae while the remaining four or five are entirely without ornamentation. The transverse costae arise gradually at the upper suture, rise in height to a point a little below the middle of the whorl face, and, it may be safely assumed, die out shortly beneath the lower line of suture. No traces of coloration are to be seen.

This species, combining small size with many, pendant whorls, sub-cylindrical form and flat base, falls rather close to *P. pagoda* and *P. restis*. It is distinguished by its partial loss of costation. It is also larger than the former and has finer, more numerous costae than the latter.

I have a single specimen from the top of the Labette shale (Zone G) at Locality 43. Holotype, Yale Peabody Museum, No. 12966.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) RESTIS KNIGHT, N. SP.
Plate 2, figure 7

Number of whorls	17[a]
Height	10 mm.?[a]
Greatest width	1.76 mm.
Apical angle, over all	13°
Apical angle, neanic	?
Pleural angle	10°
Ratio of height to width	5.7[a]
Ratio of height of body whorl to total	.21[a]
Number of costae, sixteenth (?) whorl	14

[a]Estimated on the assumption that 10 apical whorls are missing.

Sub-cylindrical; sides straight; whorl profile gently arched and slightly pendant, adpressed; sutures rather shallow; whorls moderately

high being about 53 per cent as high as wide; aperture sub-quadrate; base flat. Nucleus not seen.

Transverse costae rather strong and widely spaced. They arise abruptly at the upper suture, and, crossing the whorl face at an even height, die out just below the lower suture. They show considerable sinuosity but little obliquity. No traces of coloration are to be seen.

P. restis has much in common with *P. pagoda*, but *P. restis* is a larger, coarser form with fewer and stronger costae and the higher relative whorl height seems significant. The name is from the Latin *restis* (=rope).

One specimen only from the top of the Labette shale (Zone R), at Locality 43. Holotype, Yale Peabody Museum, No. 12967.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PAGODA KNIGHT, N. SP.
Plate 2, figure 6

Number of whorls	13
Height	3.85 mm.
Greatest width	1.1 mm.
Apical angle, over all	17°
Apical angle, neanic	30°
Pleural angle	5°
Ratio of height to width	3.5
Ratio of height of body whorl to total	.27
Number of costae, fifth whorl	21
Number of costae, twelfth whorl	21

Elongate, sub-cylindrical; sides convex at neanic and straight at ephebic stage; whorl profile well rounded, pendant and adpressed above; sutures shallow; whorls quite low, being only about 40 per cent as high as wide; aperture sub-quadrate; base markedly flat.

Transverse costae sharp, about equal to interspaces. They arise gradually from the upper suture, increase in height to somewhat below mid-whorl and die out immediately below the lower line of suture. The sinuosity is slight and the obliquity moderate. No traces of coloration observed.

This minute species stands closest to *P. terebra* and *P. restis*. It is smaller than the former, and has more numerous costae and notably lower whorls than the latter.

I have one specimen only, perhaps not quite mature, from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum No. 12968.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) SCHUCHERTI KNIGHT, N. SP.

Plate 2, figure 8

Number of whorls	12[a]
Height	14.5 mm.[a]
Greatest width	4.5 mm.
Apical angle, over all	22½°[a]
Apical angle, neanic	?
Pleural angle	17½°
Ratio of height to width	3.25[a]
Ratio of height of body whorl to total	.40[a]
Number of costae, seventh whorl	18
Number of costae, eleventh whorl	31

[a]Estimated on the assumption that 5 apical whorls are missing from the holotype.

High-spired; sides straight; whorl profile well rounded; sutures deep; aperture auriform; base rounded. Nucleus not seen.

Transverse costae rather low, sharp, with wide interspaces. They arise gradually at the upper suture, and, passing across the face of the whorl at an even height, die out just below the lower line of suture. The costae show a rather marked sinuosity, but little obliquity. No traces of color have been seen.

The comparatively numerous costae, round whorl profile and deep sutures of *P. schucherti* remind one of *P. multicostata* (Meek and Worthen) yet its costae, while numerous, are not so abundant as in that form nor are they so fine. This is a larger, coarser shell. Neither does it agree with the shell from the Wewoka formation of Oklahoma referred mistakenly, it seems to me, to Meek and Worthen's species by Girty. Girty's form has more numerous costae and is considerably larger than either *P. multicostata* or the specimen under consideration. The name is given in honor of Professor Charles Schuchert of Yale University.

Top of the Labette shale, Locality 43, one specimen. Holotype, Yale Peabody Museum, No. 12969.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PLURICOSTATA KNIGHT, N. SP.

Plate 2, figure 11

Number of whorls	12[a]
Height	8.25 mm.[a]
Greatest width	2.75 mm.
Apical angle, over all	23°
Apical angle, neanic	19°
Pleural angle	23°
Ratio of height to width	3.04[a]
Ratio of height of body whorl to total	.45[a]
Number of costae, eighth whorl	44+
Number of costae, twelfth whorl	40+

[a]Estimated on the assumption that 3 apical whorls are missing from the holotype.

High-spired; sides nearly straight, very slightly concave; whorl profile well rounded with a slight median flattening; sutures deep; aperture auriform; base rounded. Nucleus not seen.

Transverse costae fine but distinct, about equal in width to their interspaces. They arise at the upper suture, and, passing across the face of the whorl at an even height, die out at the lower line of suture. They show very slight sinuosity or obliquity. No trace of coloration is preserved.

It was after considerable hesitation that I came to the conclusion that the specimens referred here are not to be identified with *P. multicostata* (Meek and Worthen). They have in common with that form the numerous, nearly straight and vertical costae, but the sutures are considerably deeper, giving an almost beaded effect to the spire, the apical angle is somewhat less (and consequently the ratio of height to width is about 3.0 as against 2.0 for Meek and Worthen's form) the whorls are higher and *P. multicostata* does not seem to show the flattening on the sides of the whorls noted in *P. pluricostata*. Furthermore, my specimens seem to have even more numerous costae.

Keyes, Girty, and Plummer and Moore all refer specimens to Meek and Worthen's species. Keyes does not figure his forms and his description is too inadequate to allow detailed comparisons. It is quite doubtful that either Girty's or Moore's specimens, both well figured, are properly referred to *P. multicostata* as both of them are several times as large as that form or the one under consideration, not to mention other apparently valid differences.

I have two specimens from the top of the Labette shale at Locality 43, and a third, doubtfully referred because of poor preservation, from the base of the Pawnee limestone at Locality 6. Holotype, Yale Peabody Museum, No. 12970.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) DELOI KNIGHT, N. SP.
Plate 2, figure 10

Number of whorls	10
Height	8.0 mm.
Greatest width	3.0 mm.
Apical angle, over all	28½°
Apical angle, neanic	60°
Pleural angle	23°
Ratio of height to width	2.66
Ratio of height of body whorl to total	.47
Number of costae, ninth whorl	33

Elongate, conical; sides straight to slightly concave; whorl section rounded with the curvature especially sharp above; sutures deep; base

rounded; aperture sub-oval; the first two neanic whorls expanding very rapidly thus giving a blunt-tipped appearance to the shell as a whole.

Transverse costae moderately strong, well rounded and about equal in width or a little wider than their interspaces. They show very little sinuosity or obliquity. They arise abruptly at the upper suture, and, passing across the whorl face at an even height, die out rather gradually just below the lower line of suture. No traces of coloration have been seen.

P. deloi has much in common with *P. obtusicacuminis*, most notably the blunt apex caused by abnormally rapid expansion of the neanic whorls. It is distinguished chiefly by its round whorl profile, deep sutures and greater pleural angle. It has coarser costae and a lower whorl section than *P. pluricostata*, to which it otherwise shows some resemblance. It also seems to have two less whorls than the compared species, but the only specimen may not be quite mature. The name is for Mr. David N. Delo.

One specimen from the top of the Labette shale (Zone R) at Locality 43. Holotype, Yale Peabody Museum, No. 12971.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) NIGRA KNIGHT, N. SP.
Plate 2, figures 14a-b

Number of whorls	12[a]
Height	6.06 mm.
Greatest width	2.1 mm.
Apical angle, over all	21°[a]
Apical angle, neanic	28°[a]
Pleural angle	16½°
Ratio of height to width	3.0[a]
Ratio of height of body whorl to total	.41[a]

[a]Estimated on the assumption that the 3 nuclear whorls are missing from the holotype.

High-spired; sides very slightly convex at neanic stages and straight at ephebic; whorl profile gently arched, very slightly pendant; sutures only moderately deep; whorls about half as high as wide; aperture auriform, base rounded.

None of the four specimens referred here show the slightest trace of costae, and are entirely without ornamentation other than fine and sporadic lines of growth. The holotype is almost black in color and the color has a translucent appearance that suggests that it is original.

Among the smooth forms with which *P. nigra* might be confused, *P. semicostata* is perhaps the closest. Yet *P. nigra* can be readily enough distinguished by its relatively deeper sutures, its typically less pendant

whorl profile, by its less attenuated form, and by its fewer whorls and smaller size. A crowding of the growth lines near the aperture suggests that the latter criteria do not in this instance reflect immaturity.

I have four specimens from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 12972.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PUPA KNIGHT, N. SP.
Plate 2, figure 13

Number of whorls	12[a]
Height	5.6 mm.[a]
Greatest width	2.04 mm.
Apical angle, over all	29°[a]
Apical angle, neanic	46°[a]
Pleural angle	10°
Ratio of height to width	3.64[a]
Ratio of height of body whorl to total	.43[a]
Number of costae, eleventh whorl	21

[a]Estimated on the assumption that 4 apical whorls are missing.

Elongate bee-hive-shaped; sides quite convex; whorl profile very gently arched, nearly flat; sutures very shallow; whorls low, about 35 per cent as high as wide; aperture and base rounded. Nucleus not seen.

Transverse costae low, rounded with equal or wider interspaces. The costae arise gradually from the upper suture, and, passing across the face of the whorl at an even height, die out just below the lower line of suture. They show very little arching or obliquity. No traces of coloration are to be seen.

The arched sides and very low whorls of this shell are quite distinctive. It approaches most nearly, perhaps, to *P. recticostata* but is readily separated from that species by its low, wide whorls. It is considerably larger than *P. nana* (Girty) and *P. teres* (Girty) and has much lower, wider whorls and finer, more numerous costae than either.

I have two specimens, both from the top of the Labette shale, Zone R, at Locality 43. Holotype, Yale Peabody Museum, No. 12973.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) KELLETTAE KNIGHT, N. SP.
Plate 2, figures 15a-b

Number of whorls	11
Height	5.1 mm.
Greatest width	1.8 mm.
Apical angle, over all	27°
Apical angle, neanic	35°
Pleural angle	17°
Ratio of height to width	2.8
Ratio of height of body whorl to total	.40
Number of costae, fifth whorl	22
Number of costae, tenth whorl	19

Moderately high-spired; sides convex throughout; whorl profile flatly and evenly arched; whorls about half as high as wide; sutures shallow; aperture auriform; base rounded.

Transverse costae weaker on the younger and stronger on the mature whorls, except perhaps the final half volution where they are finer and more crowded; moderately sinuate; very slightly oblique; seemingly wider than their interspaces; the costae arise rather abruptly at the upper suture and, passing across the face of the whorl at an even height, die out rather gradually a little below the line of the lower suture. The coloration is preserved on one specimen, although rather poorly, and seems to consist of a vaguely defined dark revolving band passing around the whorls and covering slightly more than the lower half of the whorl face. The nucleus appears to be dark.

P. kelle'tae is characterized by its somewhat stubby shape and convex sides coupled with its relatively strong costation. The sides, convex though they are at later stages, are very slightly concave for a short distance below the nucleus, which gives a rather characteristic appearance.

Having rather numerous specimens, it may be of interest to study briefly the range of variation of mature individuals. The number of whorls seems very constant; the height ranges from 4.8 mm. to 5.21 mm.; the width from 1.73 mm. to 1.81 mm.; the over all apical angle is quite constant at 25° to 27°; the neanic apical angle 31° to 39° and the pleural angle 11° to 17°. The ratio of height to width ranges from 2.74 to 2.94 the relative height of the body whorl from 0.40 to 0.45. The number of costae at neanic stages seems rather constant at 22 to 23 while at ephebic stages there appears to be a range from 19 to 24.

The name is in honor of Miss Betty Kellett of the Amerada Petroleum Corporation.

I have 34 specimens from the top of the Labette shale at Locality 43, 3 of these from Zone G, 4 from Zone R, and the rest unallocated. Holotype, Yale Peabody Museum, No. 12794.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) RECTICOSTATA KNIGHT, N. SP.

Plate 2, figure 16

Number of whorls	11
Height	6.8 mm.
Greatest width	2.75 mm.
Apical angle, over all	28°
Apical angle, neanic	43°
Pleural angle	15°
Ratio of height to width	2.5
Ratio of height of body whorl to total	.43
Number of costae, fifth whorl	25
Number of costae, tenth whorl	24

Moderately high-spired; sides convex throughout; whorl profile flatly and evenly arched; whorls about 40 per cent as high as wide; sutures quite shallow; aperture auriform; base rounded.

Costae numerous, low, sharp, with very little sinuosity or obliquity. They arise abruptly at the upper suture and, passing down over the face of the whorl at an even height, die out just below the lower line of suture.

P. recticostata is, in its general expression, quite similar to *P. kellettae*. It is distinguished by its somewhat larger size and generally more numerous and straighter costae.

I have four specimens from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 12975.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) INORNATA KNIGHT, N. SP.
Plate 2, figure 19

Number of whorls	12
Height	7.4 mm.
Greatest width	2.65 mm.
Apical angle, over all	26°
Apical angle, neanic	43°
Pleural angle	17°
Ratio of height to width	2.9
Ratio of height of body whorl to total	.44

Moderately high-spired; sides convex throughout; whorl profile flatly and evenly arched; whorls about half as high as wide; sutures shallow; aperture auriform; base rounded.

Typically smooth and without ornamentation on all post-nuclear whorls, but exceptionally, as in the holotype, exceedingly faint traces of costae may be found on perhaps two or three of the uppermost neanic volutions. Faint traces of a narrow dark band passing around the whorls at or just above the lower suture can be detected on two specimens.

P. inornata may be distinguished from other known unornamented species by its relatively short convex form, and from species of similar form such as *P. kellettae* and *P. recticostata* by its almost complete lack of costae.

Top of the Labette shale, Locality 43, 10 specimens, of which 6 are from Zone R, leaving 4 unallocated. Holotype, Yale Peabody Museum, No. 12976.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) OBTUSICACUMINIS KNIGHT, N. SP.

Plate 2, figure 17

Number of whorls	12
Height	8.3 mm.
Greatest width	2.7 mm.
Apical angle, over all	24°
Apical angle, neanic	34°
Pleural angle	13°
Ratio of height to width	3.1
Ratio of height of body whorl to total	.36
Number of costae, eleventh whorl	29

Sub-cylindrical; sides convex at neanic and straight at ephebic stages; whorl profile very gently arched and slightly shouldered; sutures shallow; base rounded; aperture sub-oval; the first neanic whorl or two expanding more rapidly than normal giving the shell as a whole a blunted appearance.

Transverse costae low, even, well rounded and with narrow interspaces, with little sinuosity but fair obliquity. The costae arise abruptly at the upper suture and, passing across the whorl face at an even height, die out more gradually a little below the lower line of suture. No traces of coloration have been observed.

The sub-cylindrical form and slightly shouldered whorl-profile suggest the subgenus *Pyrgozyga* and yet the rounded base with an arcuate columella seem to require its placement with the subgenus *Pseudozygopleura* close to *P. assertonsoris*. From this latter it differs in its larger size, coarser costae and blunted apex.

There are on hand 4 specimens from the top of the Labette shale (Zone G) at Locality 43. Holotype, Yale Peabody Museum, No. 12977.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) ASSERTONSORIS KNIGHT, N. SP.

Plate 3, figures 1a-b

Number of whorls	14
Height	4.8 mm.
Greatest width	1.36 mm.
Apical angle, over all	18°
Apical angle, neanic	33°
Pleural angle	11°
Ratio of height to width	3.72
Ratio of height of body whorl to total	.36
Number of costae, seventh whorl	21
Number of costae, twelfth whorl	29

Attenuate, sub-conical; sides straight at ephebic stages, convex at neanic; whorl profile very gently arched; sutures quite shallow; whorls about half as high as wide; aperture auriform; base rounded.

Transverse costae narrow, rounded, somewhat irregular, about equal to their interspaces in width, with slight sinuosity and little obliquity. They arise rather abruptly at the upper suture and, crossing the whorl face at an even height, die out just below the lower line of suture. There is a well expressed tendency for the costae to become progressively less distinct on the later whorls. Coloration is well preserved and a striking feature on three of my specimens of this species. It consists of a broad dark revolving band passing around the lower half to five-eighths of the whorl face. This band is more clearly delimited in some individuals than others and may pass part way onto the base.

This minute, delicate species hardly needs comparison. Perhaps the nearest to it is *P. tenuivirga* which is slightly larger and more robust and has rather stronger and fewer costae. The color band, also well preserved in many specimens of the latter species, is narrower and confined rather closely to the immediate neighborhood of the lower suture.

The name, derived from the Latin *asser* (= pole) and *tonsor* (= barber), was suggested by the color markings which remind one of the barber pole.

Top of the Labette shale, Locality 43, 6 specimens. Holotype, Yale Peabody Museum, No. 12978.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) TENUIVIRGA KNIGHT, N. SP.
Plate 2, figures 18a-b

Number of whorls	12
Height	5.18 mm.
Greatest width	1.57 mm.
Apical angle, over all	22°
Apical angle, neanic	36°
Pleural angle	18°
Ratio of height to width	3.3
Ratio of height of body whorl to total	.39
Number of costae, sixth whorl	12
Number of costae, eleventh whorl	15

Elongate conical, sides slightly convex; whorl profile very gently and evenly arched; sutures shallow; whorls about half as high as wide; aperture auriform; base rounded.

Transverse costae rather strong, very slightly sinuous and oblique, about equal to interspaces in width. They arise abruptly at the upper suture, cross the whorl at an even height and die out just below the lower line of suture. A considerable number of specimens have well preserved coloration consisting of a rather narrow dark revolving band extending just above the lower suture and partly covered by it.

P. tenuivirga differs from *P. assertonsoris* in its more robust form and costae, fewer whorls and narrower color band. It is much smaller than most forms with which comparison might be made. It is larger, and more coarsely costate than either *P. nana* (Girty) or *P. teres* (Girty) and both these species are almost pupaeform in outline. The name is derived from the Latin *tenuis* (=thin) and *virga* (=colored stripe).

Top of the Labette shale, Locality 43, 27 specimens, of which 7 are from Zone R and the rest unallocated. One poorly preserved specimen from the base of the Pawnee limestone at locality 6 is doubtfully referred here. Holotype, Yale Peabody Museum, No. 12979.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) LEVENEAE KNIGHT, N. SP.
Plate 3, figures 2a-b

Number of whorls	11
Height	5.5 mm.
Greatest width	1.9 mm.
Apical angle, over all	24½°
Apical angle, neanic	30°
Pleural angle	18½°
Ratio of height to width	2.93
Ratio of height of body whorl to total	.44
Number of costae, fifth whorl	16
Number of costae, tenth whorl	23

Moderately high-spired; sides very slightly convex; whorl profile very slightly and evenly arched; whorls about half as high as wide; sutures shallow; aperture auriform; base rounded.

Transverse costae low, rounded, a little wider than or equal to their interspaces, with moderate sinuosity and little obliquity. They arise abruptly at the upper suture, and, crossing the whorl face at an even height, die out just below the lower line of suture. In this species rather more markedly than in most others the costae become crowded and indistinct on the final whorl, or they may be entirely lacking. In a number of specimens the final whorl and more particularly its lower half is uniformly dark in color; this tint grades rather evenly into the lighter gray of the spire.

P. leveneae probably approaches more closely to *P. kellettae* than to any other species but is distinguished by its more slender form, and its more rounded and lower costae which tend markedly to obsolescence on the final whorl. The name is in honor of Miss Clara Mae Levene, of Yale University.

Top of Labette shale at Locality 43, 27 specimens of which 2 are from Zone R, and 25 unallocated. Holotype, Yale Peabody Museum, No. 12980.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) ACUMINATA KNIGHT, N. SP.
Plate 3, figure 3

Number of whorls	14[a]
Height	9.5 mm.[a]
Greatest width	2.25 mm.
Apical angle, over all	15°[a]
Apical angle, neanic	22½°[a]
Pleural angle	11½°
Ratio of height to width	4.23[a]
Ratio of height of body whorl to total	.81[a]
Number of costae, sixth whorl	14
Number of costae, thirteenth whorl	15

[a]Estimated on the assumption that the holotype lacks a single initial whorl.

Acuminate, high-spired; sides nearly straight at all stages, only very slightly convex at neanic; whorl profile flatly rounded, neither shouldered nor pendant; sutures shallow; whorls relatively high, being about 60 per cent as high as wide; aperture auriform; base rounded, slightly flattened.

Transverse costae low, sharp, well defined; interspaces about equal to or a little broader than costae. The costae arise rather abruptly at the upper suture, pass across the face of the whorl at an even height and die out at the lower suture. Sinuosity and obliquity very slight. No traces of coloration have been seen.

P. acuminata is well differentiated from any known forms by its flat straight sides, flat whorl profile, its general shape of a marlin spike and its straight, even costae. Nevertheless, since these characters are not so conspicuous at young stages, it may be difficult to recognize the species when only represented by immature specimens. Yet even the young show only to a less degree the acuminate spire and nearly straight sides.

I have two specimens, one of them immature, both from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 12981.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PRAEACUTA KNIGHT, N. SP.
Plate 3, figure 4

Number of whorls	14
Height	8.0 mm.
Greatest width	2.1 mm.
Apical angle, over all	17°
Apical angle, neanic	?°
Pleural angle	11°
Ratio of height to width	3.9
Ratio of height of body whorl to total	.31
Number of costae, sixth whorl (of paratype)	14

Acuminately high-spired; sides nearly straight at all stages, only very slightly convex at neanic; whorl profile very flatly rounded; sutures shallow; whorls of medium height typically a little more than 50 per cent as high as wide; aperture sub-quadrate; base distinctly flattened.

There is a tendency to suppression of costae. The holotype shows faint traces of costae only on the first two or three post-nuclear whorls, but the paratype, an immature specimen, carries rather coarse costae to the seventh whorl from which point it is quite without ornamentation. No traces of coloration seen except that the nucleus is dark.

P. praeacuta is differentiated from other forms wholly or partially without ornamentation by its acuminate flat-sided spire and from *P. acuminata* by its tendency toward more or less complete suppression of the costae, by its flatter base and somewhat lower whorls.

Two specimens were collected, both from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 12982.

PSEUDOZYGOPLEURA (PSEUDOZYGOPLEURA) PERVERSA KNIGHT, N. SP.
Plate 2, figures 12a-b

Number of whorls	11
Height	5.65 mm.
Width	.98 mm.
Apical angle, over all	20°
Apical angle, neanic	37°
Pleural angle	10°
Ratio of height to width	5.6
Ratio of height of body whorl to total	.24
Number of costae, tenth whorl	17

Sinistrally coiled; narrowly conical; sides slightly convex; whorl profile very gently arched, pendant, adpressed; sutures shallow; base rounded; aperture auriform.

The transverse costae are low and rounded; about equal to their interspaces in width. They arise at the upper suture, increase slightly in height as they pass across the whorl face and die out just below the line of the lower suture. They show a moderate sinuosity and obliquity normal in direction for a sinistral shell. The costae become crowded, fine and obscure on the final whorl. No traces of color have been seen

Plummer and Moore figure as *Hemizyga* sp. (Texas Univ. Bull. 2132, Pl. 19) what seems to be a sinistral form of *Pseudozygopleura*. This shell is apparently larger and more attenuated than *P. perversa* though in many respects much like it. It does not seem to be a *Hemizyga*. Further than this no other sinistral forms are known.

I have three specimens from the top of the Labette shale, Locality 43, two of which are assignable to Zone G. Holotype, Yale Peabody Museum, No. 12983.

SUBGENUS PYRGOZYGA KNIGHT, N. SUBG.

PSEUDOZYGOPLEURA (PYRGOZYGA) CYLINDRATA KNIGHT, N. SP.
Plate 3, figures 6a-b

Number of whorls	25[a]
Height	13.5 mm.[a]
Greatest width	2.8 mm.
Apical angle, over all	14°[a]
Apical angle, neanic	?
Pleural angle	4.5°
Ratio of height to width	4.8[a]
Ratio of height of body whorl to total	.16[a]
Number of costae, eighth whorl	15
Number of costae, twenty-fourth whorl	23

[a]Estimated on the assumption that 5 apical whorls are missing.

Sub-cylindrical; extremely high-spired and with numerous volutions; sides convex in early neanic stages and straight thereafter; whorl profile flat and shouldered; whorls distinctly low, their height being something less than 40 per cent of their width; aperture sub-quadrate; base flatly rounded.

Transverse costae sharp with rather broad interspaces. The costae arise abruptly at the upper suture, pass across the face of the whorl at an even height and die out just below the lower line of suture. They show almost no sinuosity and only slight normal obliquity. One specimen from the top of the Labette shale shows distinct traces of coloration in the form of a revolving dark band occupying the upper half of the exposed side of each volution. The color band does not quite reach the suture.

This species is very distinctive. Its high spire, cylindrical form and numerous, very low whorls are not duplicated among any forms known to me.

The holotype is from the base of the Pawnee limestone at Locality 6. Seven additional specimens are from the top of the Labette shale at Locality 43, four of which are known to be from Zone G and one from Zone R. Holotype, Yale Peabody Museum, No. 12984.

PSEUDOZYGOPLEURA (PYRGOZYGA) MACRA KNIGHT, N. SP.
Plate 3, figures 7a-d

Number of whorls	18
Height	10.3 mm.
Greatest width	2.3 mm.
Apical angle, over all	18½°
Apical angle, neanic	28°
Pleural angle	9°
Ratio of height to width	3.6
Ratio of height of body whorl to total	.24
Number of costae, seventh whorl	15
Number of costae, seventeenth whorl	26

Measurements estimated on the basis of both the holotype (lacking about ten apical whorls) and a paratype, an immature specimen.

Sub-cylindrical and high-spired; sides slightly convex at neanic stage, straight at ephebic; whorl profile very flatly arched, slightly shouldered; whorls relatively low, about 45 per cent as high as wide; sutures shallow; base flatly rounded; aperture sub-quadrate.

Transverse costae low, rounded, appearing a little wider than their interspaces. They arise on the shoulder at the upper suture, pass across the face of the whorl at an even height and die out just below the lower line of suture; sinuosity and obliquity very slight. The coloration, which is faintly visible on the holotype, consists of a narrow, dark revolving band passing around the whorls a little above the lower suture and extending up the sides to a very little above midway from suture to suture.

P. macra resembles somewhat closely *P. dunbari* but is definitely a smaller and finer shell at the same growth stages. Its color band is much the same as that of *P. dunbari* but is relatively narrower and seems to be placed slightly higher on the whorl. The name was chosen with reference to its attenuated form (Lat. *macer* = lean).

Twenty-one specimens, many of them immature, were collected from the top of the Labette shale at Locality 43. Three of these are from Zone R, one from Zone G, with seventeen unallocated. Holotype, Yale Peabody Museum, No. 12985.

PSEUDOZYGOPLEURA (PYRGOZYGA) DUNBARI KNIGHT, N. SP.
Plate 3, figures 8a-b

Number of whorls	18[a]
Height	12 mm.[a]
Greatest width	2.85 mm.
Apical angle, over all	15°[a]
Apical angle, neanic	29°[b]
Pleural angle	15°
Ratio of height to width	4.15[a]
Ratio of height of body whorl to total	.24[a]
Number of costae, seventeenth whorl	17

[a]Estimated on the assumption that 10 apical whorls are missing from the holotype.

[b]Measured on the figured paratype, a young individual.

High-spired and attenuated, sides straight at ephebic stage, somewhat convex at neanic; whorl profile gently arched and shouldered; sutures shallow; aperture sub-quadrate; base somewhat flatly rounded.

Transverse costae strong, typically rounded, seemingly wider than their interspaces, with rather slight sinuosity and obliquity. They arise abruptly at the upper suture, pass across the face of the whorl at an even height and die out just below the lower line of suture. Several of my specimens preserve traces of coloration. It consists of a dark revolving band covering the lower five-eighths of the exposed face of the whorls. The nucleus is dark. One specimen referred to the species is entirely a very dark gray and it is not known whether this represents original coloration or is secondary or, if it is original, what weight should be given it as a specific character.

P. dunbari is differentiated from *P. cylindrata* by its coarser, less numerous costae, its less well developed whorl shoulders and its greater relative whorl height. The last in *P. dunbari* is about 48 per cent of the width as against 45 per cent or less in the compared species. *P. macra* is a smaller and altogether finer form while *P. marvinwelleri* of much the same size and form has much more numerous and finer costae. The name is in honor of Professor Carl O. Dunbar, of Yale University.

I am referring to this species 35 specimens from the top of the Labette shale at Locality 43; of these 4 are from Zone R, 8 from Zone G, while 23 are unallocated. Holotype, Yale Peabody Museum, No. 12986.

PSEUDOZYGOPLEURA (PYRGOZYGA) MARVINWELLERI KNIGHT, N. SP.
Plate 3, figures 9a-b

Number of whorls	16[a]
Height	11 mm.[a]
Greatest width	2.7 mm.
Apical angle, over all	16°[a]
Apical angle, neanic	27°[a]
Pleural angle	9½°
Ratio of height to width	4.16[a]
Ratio of height of body whorl to total	.28[a]
Number of costae, tenth whorl	28
Number of costae, eighteenth whorl	34

[a]Estimated on the assumption that 5 apical whorls are missing from the holotype.

Elongate, sub-cylindrical; sides slightly convex at neanic and straight at ephebic stages; whorl profile flat, sometimes slightly shouldered; sutures not impressed; whorls relatively low, about 45 per cent as high as wide; aperture sub-quadrate; base rounded and somewhat flattened.

Transverse costae low, even, apparently wider than their interspaces and of rounded cross-section. They arise abruptly at the upper suture, pass down across the whorl face at an even height with very little sinuosity or obliquity, and die out just below the lower line of suture. No traces of coloration are preserved.

P. marvinwelleri is differentiated from similar elongate forms by its relatively numerous and low costae. *P. cylindrata* has in addition lower and more numerous volutions. The name is in honor of Dr. J. Marvin Weller, of the State Geological Survey of Illinois.

I have four specimens from the top of the Labette shale at Locality 43, two from Zone R, one from Zone G and one unallocated. Another, rather poorly preserved specimen from the Lower Fort Scott limestone at Locality 42, is somewhat doubtfully referred here. Holotype, Yale Peabody Museum, No. 12987.

PSEUDOZYGOPLEURA (PYRGOZYGA) FUNIS KNIGHT, N. SP.
Plate 3, figure 10

Number of whorls	18
Height	8.8 mm.
Greatest width	2.0 mm.[a]
Apical angle, over all	14°
Apical angle, neanic	38°
Pleural angle	12°
Ratio of height to width	4.3
Ratio of height of body whorl to total	.28
Number of costae, sixth whorl	13
Number of costae, fifteenth whorl	17

[a]Actually somewhat less as holotype is slightly mashed and measurement was taken across flattening.

Very high-spired and many-whorled; sides convex at neanic stage and straight at ephebic; whorl profile somewhat rounded and distinctly shouldered; whorls low being about 45 per cent as high as wide; aperture sub-quadrate; base flatly rounded.

Transverse costae moderately strong, of even height, apparently narrower than their interspaces; arising abruptly at the upper suture, crossing the whorl at an even height and dying out just below the lower line of suture; the last half whorl of the holotype without costae; the costae with little sinuosity but considerable obliquity. No traces of coloration have been seen.

This form seems to have much in commou with *P. cylindrata* and it is barely possible that some of the seeming points of difference, such as the rounder whorl profile of this shell may be due to mashing of the unique specimen, and yet this does not appear to be the case, for the

characters in question are described from the upper whorls which have escaped mashing. In support of their specific separation may be cited the fact that in *P. funis* the eighteen whorls, apparently the fully mature or even gerontic shell, measure 8.8 mm. as against 6.5 mm. for the first eighteen whorls of *P. cylindrata*. It should be noted that the crushing of the last several whorls of the figured type has exaggerated the convexity of the whorls and the obliquity of the costae. The name is from the Latin *funis* (= a rope).

The holotype, from the top of the Labette shale at Locality 43, is the only specimen. Holotype, Yale Peabody Museum, No. 12988.

PSEUDOZYGOPLEURA (PYRGOZYGA) WARTHINI KNIGHT, N. SP.
Plate 3, figure 5

Number of whorls	12[a]
Height	7.45 mm.[a]
Greatest width	2.2 mm.
Apical angle, over all	20°
Apical angle, neanic	?
Pleural angle	11½°
Ratio of height to width	3.4[a]
Ratio of height of body whorl to total	.37[a]

[a]Estimated on the assumption that 3 apical whorls are missing.

Elongate conical; sides convex at neanic and straight at ephebic stage; whorl profile very gently arched and slightly though distinctly shouldered; sutures shallow; whorls rather low, the height being about 45 per cent of the width; aperture sub-oval; base rounded. The nucleus has not been observed.

All post-nuclear whorls except the first four or five, which show traces of faintly developed costae, are smooth and without ornamentation other than obscure lines of growth. Both the faint costae and the growth-lines suggest that at least on the holotype the outer lip carries no sinus but slopes obliquely backward at a slight angle from the vertical. The coloration is fairly well preserved on the holotype and consists of a wide dark revolving band which occupies the whole of the whorl except the base and the uppermost edge of the volution.

This form presents close superficial resemblance to *P. semicostata* which is also nearly smooth but differs from that and other known unornamented species chiefly by its shouldered whorls and perhaps by the reversed obliquity of the margin of the outer lip. The name is in honor of Mr. A. S. Warthin, Jr., of Vassar College.

One specimen only was collected from the top of the Labette shale at Locality 43. Holotype, Yale Peabody Museum, No. 12989.

SUBGENUS STEPHANOZYGA KNIGHT, N. SUBG.

PSEUDOZYGOPLEURA (STEPHANOZYGA) SUBNODOSA KNIGHT, N. SP.

Plate 4, figure 1

Number of whorls	17+[a]
Height	35mm.+[a]
Greatest width	11 mm.
Apical angle, over all	21°[a]
Apical angle, neanic	?
Pleural angle	16°
Ratio of height to width	3.2[a]
Ratio of height of body whorl to total	.40[a]
Number of costae, fifteenth whorl	16

[a]Estimated on the assumption that 10 apical whorls are missing from the holotype.

Elongate, conical; sides straight; whorl profile rather sharply rounded below, concave above, adpressed; sutures shallow; whorls about half as high as wide; aperture sub-quadrate; base flatly rounded. Nucleus not observed.

Transverse costae short, sub-nodose, only very slightly sinuous or oblique, about equal to interspaces in width. The costae arise very gradually just below the unornamented adpressed band, about three-eighths of the suture-to-suture distance from the upper suture. They increase in height smoothly but rather steeply to a point about four-fifths of the way down where they round rather sharply and die out at the line of the lower suture rather more rapidly than they arose. The last half to three-quarters of a whorl on the holotype is without ornamentation. No traces of coloration are preserved.

S. subnodosa resembles rather closely *S. nodosa* (Girty) but in that form, which is described from the Calhoun shale of the Shawnee group, the costae are, as closely as one can measure from Girty's figure, less than half the height of the whorl face as against about five-eighths the same distance for mine. In both forms the final half volution is without ornamentation and except for the difference in the length of the costae and for the fact that Girty's species is about 30 per cent larger, they seem almost identical. There can be little question that *S. subnodosa* is in direct line of ancestry of *S. nodosa*.

Lower Fort Scott limestone, Locality 42; two specimens. Holotype Yale Peabody Museum, No. 12990.

SUBGENUS LEPTOZYGA KNIGHT, N. SUBG.

PSEUDOZYGOPLEURA (LEPTOZYGA) MINUTA KNIGHT, N. SP.

Plate 4, figure 2

Number of whorls	9
Height	2.5 mm.
Greatest width	.78 mm.
Apical angle, over all	25°
Apical angle, neanic	39°
Pleural angle	9°
Ratio of height to width	3.2
Ratio of height of body whorl to total	.46
Number of costae, fourth whorl	37+
Number of costae, seventh whorl	34+

Fusiform; sides convex; whorl profile gently arched; sutures shallow; whorls about 60 per cent as high as wide; aperture rather elongate, auriform; base subconically rounded; columella arcuate.

Transverse costae or lirae exceedingly fine, with slight sinuosity or obliquity, not quite so wide as their interspaces. They arise at the upper suture and, becoming fainter as they cross the whorl face, become obsolete in the neighborhood of the lower suture. The costae appear to become progressively weaker from earlier to the later whorls so that on the final whorl of mature individuals they may not be distinguishable.

This highly distinctive little shell hardly needs comparison.

Top of the Labette shale, Locality 43, 22 specimens, of which 14 are known to be from Zone R. Holotype, Yale Peabody Museum, No. 12991.

GENUS HELMINTHOZYGA KNIGHT, N. G.

HELMINTHOZYGA VERMICULUS KNIGHT, N. SP.

Plate 4, figures 3a-d

Number of whorls	7
Height	2.2 mm.
Width	1.0 mm.
Greatest width of whorl of holotype	.5 mm.
Greatest width of whorl of paratype	1.5 mm.
Number of costae, final whorl	13

The first four to eight whorls trochoid, after which the coiling may loosen so that the shell becomes umbilicate or more typically the growing tube may become suddenly entirely free and continue in a free, perhaps irregular, vermiform spiral. The whorl section is round as is the aperture.

On the earlier still closely-coiled post-nuclear whorls there are developed rather strong transverse costae which become more widely spaced

and rather flaring as the point of free-coiling is approached, until, when the whorl has actually become free, they become widely spaced flaring collars or varices inclined toward the apertural direction. Their course around the tube seems to be drawn away from the aperture on the outer and toward it on the inner side where they also are less strongly expressed. The shell seems then periodically to have had an unsymmetrical blunderbuss-like aperture, drawn back and flaring on the outer side and extended forward on the inner.

No traces of coloration have been observed.

I know of no other species of the genus with which to compare this unless "*Serpula*" McCoy (20, p. 169, Pl. 23, fig. 29) may be referred here, and that form is too little known to be of any value.

Top of the Labette shale (Zone G) at Locality 43, 26 specimens, of which 18 are fragments of the free volution and 8 show the early spire and nucleus. Holotype, Yale Peabody Museum, No. 12992.

Genus HEMIZYGA Girty

Subgenus PLOCEZYGA Knight, n. subg.

HEMIZYGA (PLOCEZYGA) CORONA Knight, n. sp.

Plate 4, figure 4

Number of whorls	9
Height	4.8 mm.
Greatest width	2.5 mm.
Apical angle, over all	35°
Apical angle, neanic	43°
Pleural angle	27°
Ratio of height to width	2.0
Ratio of height of body whorl to total	.50
Number of costae, fourth whorl	16
Number of costae, eighth whorl	13

Moderately high-spired; sides straight; whorl profile sharply rounded; sutures rather deep; whorls only about 40 per cent as high as wide; aperture sub-quadrate; base rounded and flattened.

Transverse costae very strong, high, rounded and almost node-like. They show no sinuosity and are equal to or perhaps wider than their interspaces. The obliquity is reversed. The costae arise at the upper suture, increase rapidly in height to a point somewhat below the middle of the whorl face where they curve sharply inward and die out just below the lower line of suture. The revolving lirae are very fine but distinct on all whorls; they are low by sharp with wide interspaces and number something like twenty on the whorl face and perhaps fifteen on the base. No traces of coloration have been seen.

This specimen approaches most closely to *P. angularis* but it may be distinguished from this and all other species known to me by its almost exaggerated costae. The relatively few whorls on the two specimens in hand suggest that they may not be quite mature, but the irregular gerontic costation on the last half volution disproves this.

Top of the Labette shale, Locality 43, two specimens, of which one is assignable to Zone G. Holotype, Yale Peabody Museum, No. 12993.

HEMIZYGA (PLOCEZYGA) ANGULARIS KNIGHT, N. SP.

Plate 4, figures 8a-b

Number of whorls	11
Height	6.8 mm.
Greatest width	2.84 mm.
Apical angle, over all	32°
Apical angle, neanic	37°
Pleural angle	23°
Ratio of height to width	2.4
Ratio of height of body whorl to total	.46
Number of costae, fifth whorl	19
Number of costae, tenth whorl	15

High-spired; sides straight; whorl profile sharply rounded, almost sub-angular medially; sutures rather deep; whorls about half as high as wide; aperture sub-quadrate; base quite flatly rounded.

Transverse costae in cross-section rather low with broad interspaces. They show no sinuosity and a reversed obliquity. They are relatively high midway between sutures, low to the vanishing point at each suture, and do not pass onto the base.

The revolving lirae, of which there are about fifteen between sutures, are very fine. Those on the base are especially fine and difficult to see, although definitely present.

P. angularis is closest to *P. corona* but is larger, has higher whorls, less prominent costae and fewer and less distinct revolving lirae on the whorl face. Its angular whorl profile, smaller size and more flattened base serve to distinguish it from *P. tenuilirata*.

Top of the Labette shale, Locality 43, 22 specimens, half of them known to come from Zone G. Holotype, Yale Peabody Museum, No. 12994.

HEMIZYGA (PLOCEZYGA) TENUIS KNIGHT, N. SP.

Plate 4, figure 9

Number of whorls	9
Height	4.7 mm.
Width	1.94 mm
Apical angle, over all	30°
Apical angle, neanic	40°
Pleural angle	20°
Ratio of height to width	2.4
Ratio of height of body whorl to total	.48
Number of cosate, eighth whorl	.14

Elongate, conical; sides very gently arched; whorl profile well arched; sutures moderately deep; base rounded; aperture auriform. The nucleus has not been seen.

The transverse costae are rather strong, rounded and about equal in width to interspaces. They arise at the upper suture, pass across the whorl face at an even height and die out rather gradually below the line of the lower suture. They show no sinuosity but there is considerable reversed obliquity. The revolving lirae are well developed and although the state of preservation of the holotype makes a count difficult, they seem to number about fifteen from suture to suture. No traces of color are preserved.

This species is distinguished among the forms here described by its relatively acute spire combined with a well-rounded whorl-profile. It seems quite close to *P. costata* (Mark) but is apparently narrower and somewhat larger. If the number of revolving lirae shown on the rather unsatisfactory figure of Miss Mark's species is significant, my species is further differentiated from it in that it carries about twice the number shown on that form.

Top of the Labette shale (Zone R), at Locality 43, one specimen. Holotype, Yale Peabody Museum, No. 12995.

HEMIZYGA (PLOCEZYGA) ABOLESCENS KNIGHT, N. SP.
Plate 4, figure 7

Number of whorls	8[a]
Height	5 mm.[a]
Greatest width	1.62 mm.
Apical angle, over all	39°[a]
Apical angle, neanic	34°
Pleural angle	39°
Ratio of height to width	3.08[a]
Ratio of height of body whorl to total	.55
Wphebic costae too faint to count	

[a]Estimated on the assumption that 1 apical whorl is missing.

Moderately high-spired; sides straight to slightly concave; whorl profile well rounded; sutures deep; base rounded; aperture sub-oval; The nucleus of the holotype and only specimen although partially preserved seems to be only faintly sculptured.

The transverse costae are very faint, scarcely stronger than growth-lines, and a minute microscopic examination is needed to find traces of revolving lirae. The transverse costae show no sinuosity or well marked reversed obliquity. No traces of coloration are observed.

This species is clearly referable to *Plocezyga* on the basis of both its form and ornamentation and it seems to represent rather extreme although not complete repression of ornamentation in that subgenus of *Hemizyga*. This latter character sets it apart from any other species known to me. It is interesting to note that while repression of adult ornamentation in *Pseudozygopleura* does not affect the nuclear ornamentation, in *Plocezyga* the opposite seems to be the case if the surface of the partially preserved nucleus of the specimen under consideration represents the true condition.

One specimen from the top of the Labette shale (Zone G) Locality 43. Holotype, Yale Peabody Museum, No. 12996.

HEMIZYGA (PLOCEZYGA) TENUILIRATA KNIGHT, N. SP.
Plate 4, figures 5a-b

Number of whorls	13[a]
Height	9.75 mm.[a]
Greatest width	3.75 mm.
Apical angle, over all	29°
Apical angle, neanic	?
Pleural angle	12°
Ratio of height to width	2.6[a]
Ratio of height of body whorl to total	.44[a]
Number of costae, seventh whorl	19
Number of costae, eleventh whorl	18

[a]Estimated on the assumption that 7 apical whorls are missing.

High-spired; sides straight to slightly concave; whorl profile rather sharply and evenly rounded; sutures moderately deep, whorls about half as high as wide; aperture sub-quadrate; base rounded and somewhat flattened close to columella.

Transverse costae with broadly angular cross-section and subequal angular interspaces; they are slightly sinuous and some specimens show a slight forward obliquity although in others it is reversed. The costae arise at the upper suture, increase gradually in height to about the middle and then gradually decline, to die out just below the lower line of suture. The revolving lirae are very fine, have wide interspaces and are to be seen only on specimens with exceptionally well preserved surfaces. On the holotype there are about twenty between sutures, and many more on the base. No traces of coloration have been observed.

P. tenuilirata hardly needs comparisons with other Hemizygae here described. It is perhaps closest to *P. dubia* (Girty) but is distinguishable from that form by its fewer, much wider costae. When the state of preservation does not permit the revolving lirae to be seen it

might more readily be mistaken for some member of the Pseudozygopleurae such as *P. moorei*, but its more rapidly expanding, rounder whorls and deeper sutures and, to one familiar with the group, its hemizygoid expression serve to distinguish it.

Top of the Labette shale, Locality 43, 7 specimens. Holotype, Yale Peabody Museum, No. 12997.

HEMIZYGA (PLOCEZYGA) PERCOSTATA KNIGHT, N. SP.
Plate 4, figure 6

Number of whorls	7
Height	4.75mm.
Greatest width	3.44mm.
Apical angle, over all	62°
Apical angle, neanic	62°
Pleural angle	62°
Ratio of height to width	1.38
Ratio of height of body whorl to total	.60
Number of costae, final whorl	11

Relatively low-spired and sub-turbinate; sides straight; whorl profile sharply rounded; sutures deep; base rounded, slightly flattened; aperture sub-circular. Shell notably thick.

The ornamentation consists of transverse costae and revolving lirae. The former are exceedingly strong, almost exaggerated. They arise very gradually at the upper suture, reach their maximum height a little below the middle of the whorl face and die away gradually below the lower line of suture. They show almost no sinuosity but very striking reversed obliquity. The revolving lirae are exceedingly fine and numerous, finer indeed than the occasional transverse growth lines with which they form the woof of a fine network covering the whole surface of the shell including the very prominent transverse costae. No traces of coloration have been observed.

This species cannot well be confused with any other as yet known. It seems to combine the sub-turbinate shape of *P. corbis* with the exaggerated costation of *P. corona* and yet it is clearly and readily distinguishable from either by characters that are too numerous and self-evident to need specific mention.

The top of the Labette shale (Zone G) at Locality 43 has yielded all of the ten specimens at hand. Holotype, Yale Peabody Museum, No. 12998.

SUBGENUS HEMIZYGA GIRTY, S. S.

HEMIZYGA (HEMIZYGA) INFLATA KNIGHT, N. SP.

Plate 5, figure 1

Number of whorls	13[a]
Height	8.5 mm.[a]
Greatest width	4.25 mm.
Apical angle, over all	34°[a]
Apical angle, neanic	24°
Pleural angle	45°
Ratio of height to width	2.0[a]
Ratio of height of body whorl to total	.5[a]
Number of costae, eighth whorl	23
Number of costae, twelfth whorl	80+

[a]Estimated on the assumption that 6 apical whorls are missing.

High-spired; body whorl somewhat inflated; sides concave; whorl profile well rounded; sutures deep; aperture ovoid; base rounded. Nucleus not seen.

Transverse costae relatively and actually stronger and larger at neanic stage than on the last four whorls, and as a result not only of this but of the rapid increase in circumference of the later whorls they are very much more numerous on the latter. The costae (or lirae) are low and of even height but still sharp, rounded and about equal to their interspaces in width. They pass entirely across the whorl from the upper suture to the columellar lip with a reversed obliquity and no sinuosity. The revolving lirae are much finer than the costae, are rounded and of about half the width of their interspaces. They are numerous, but on the specimens in hand are not well enough preserved to be counted. They are most clearly seen on the basal part of the final volution but also, though very faintly, between the costae on the faces of all whorls. Both the transverse and revolving costae or lirae become increasingly irregular as the apertural margin is approached, this in all probability being a gerontic character. No traces of coloration are preserved.

H. inflata is characterized by its deep sutures, inflated whorls, together with its rather fine costae and revolving lirae.

Top of the Labette shale, Locality 43, one specimen. Holotype, Yale Peabody Museum, No. 12999.

HEMIZYGA (HEMIZYGA) CORBIS KNIGHT, N. SP.
Plate 4, figure 10; Plate 5, figure 3

Number of whorls	8[a]
Height	8.65 mm.[a]
Greatest width	6.1 mm.
Apical angle, over all	48°[b]
Apical angle, neanic	42°[b]
Pleural angle	51°[b]
Ratio of height to width	1.42[a]
Ratio of height of body whorl to total	.68[a]
Number of costae, fifth whorl	15
Number of costae, final whorl	38

[a]Estimated on the assumption that 3 apical whorls are missing.

[b]The specimen is somewhat mashed in the plane in which these angles were measured and hence the values given are larger than the true values.

Only moderately high-spired, sub-turbinate; sides slightly concave; whorl profile rounded; sutures moderately deep; base rounded; aperture widely sub-oval. The columellar lip instead of being thin and reflexed seems to be thickened, almost callused at mature stages.

The ornamentation consists of both transverse costae and revolving lirae. The transverse costae are on the younger whorls rather strong and of an even height but become progressively weaker and more crowded as the aperture is approached. They arise rather gradually from the upper sutures, pass across the whorl face at an even height and across the base much less distinctly. Both obliquity and sinuosity are reversed. The revolving lirae are both abundant and prominent and number something like twenty-seven on the whorl face between sutures. Fifty were counted on the final whorl of an immature specimen. No traces of coloration are to be seen.

This species is characterized amongst Hemizygae (*ss.*) known to me by the strong development of its revolving lirae. Its sub-turbinate form also seems distinctive though *H. corpulentissima* is somewhat similar in this respect but has coarser, more widely spaced costae and seems to be without revolving ornamentation.

Top of the Labette shale at Locality 43, three specimens, of which one can be definitely allocated to Zone R. Holotype, Yale Peabody Museum, No. 12000.

HEMIZYGA (HEMIZYGA) ILLINEATA KNIGHT, N. SP.
Plate 5, figures 2a-b

Number of whorls	9[a]
Height	17.5 mm.[a]
Greatest width	8.75 mm.
Apical angle, over all	40½°[a]
Apical angle, neanic	51°
Pleural angle	32°
Ratio of height to width	2.0[a]
Ratio of height of body whorl to total	.64[a]
Number of costae, fifth whorl	27
Number of costae, final whorl	54

[a]Estimated on the assumption that 3 apical whorls are missing.

Moderately high-spired; sides slightly convex; whorl profile well arched; sutures rather deep; base rounded; aperture rather elongate, sub-oval. The shell of this species being rather thick the reflexed columellar lip of the subfamily is represented by a thickening, as in the recent species *Littorina littorea* (Linné). This thickening or callus is confined to the columellar lip and does not extend onto the base of the preceding whorl. The nucleus has not been seen.

The ornamentation consists of transverse costae alone. On the younger whorls they are rather strong, even, well rounded and about equal to their interspaces in width. As the aperture is approached they become more and more crowded and irregular until the interspaces may finally be said to approximate striae between the irregularly wider costae. The costae arise gradually from the upper suture and pass completely across the whorl and its base, showing not only reversed obliquity but sinuosity as well. Careful examination of two very perfect specimens has failed to disclose any sign of the expected revolving lirae. No traces of coloration other than that the callus is dark are to be seen.

The reference of this species, without revolving ornamentation, without the typical inner lip and without having seen its nucleus, to *Hemizyga* or even to the Pseudozygopleurinae can only be made tentatively. And yet its general form and type of costation are so identical with *Hemizyga* that one is almost compelled to infer here the suppression of revolving ornamentation and to regard it and the thickening of the columellar lip as of specific value only. The extremely rapid evolution within the group would lend some support to this concept. *H. illineata* suggests *H. grandicostata* Girty in its general makeup but is larger and lacks the revolving ornamentation shown by that species.

Top of the Labette shale (Zone G), Locality 43, two specimens. Holotype, Yale Peabody Museum, No. 13001.

HEMIZYGA (HEMIZYGA) CORPULENTISSIMA KNIGHT, N. SP.
Plate 5, figure 4

Number of whorls	8
Height	9.5 mm.
Greatest width	5.9 mm.
Apical angle, over all	55°
Apical angle, neanic	47°
Pleural angle	53°
Ratio of height to width	1.6
Ratio of height of body whorl to total	.66
Number of costae, fifth whorl	18
Number of costae, seventh whorl	16

Sub-turbinate; body whorl relatively large; sides straight to very slightly concave; whorl profile well rounded; sutures only moderately deep; whorl face relatively low due to relatively deep immersion in the succeeding whorl; aperture auriform; base sub-conically rounded. Columellar lip callused rather than thin and reflexed due to thickness of the shell. The nucleus is poorly preserved.

Transverse costae rather sharp, with almost no sinuosity, but showing reversed obliquity, and wide interspaces. The costae arise very gradually from the upper suture, attain their maximum height about half way down the whorl face and gradually die out on the base. The revolving lirae are so obscure that there is some doubt as to whether or not they are developed. Yet their presence is suggested at a number of points on several specimens.

The reference of this species to *Hemizyga* is made with even greater hesitancy than with *H. illineata* and is suggested more perhaps by what it has in common with that species than by its own characters. The widely spaced costae appearing only faintly on the base suggest *Plocezyga* and yet many of its characters approach more closely to those of *H. illineata* than to those of any member of the typically more strongly costate genus. Perhaps these two species should form the nucleus of another subgenus in which the revolving ornamentation tends to become obsolete. The widely spaced costae and sub-turbinate form will serve to distinguish this species from *H. illineata* while its almost if not entire lack of revolving lirae will do the same service in respect to *Plocezyga corbis* which has much the same shape.

I have four specimens from the top of the Labette shale at Locality 43, two of them definitely from Zone G. Holotype, Yale Peabody Museum, No. 13002.

SUBGENUS HYPHANTOZYGA KNIGHT, N. SUBG.

HEMIZYGA (HYPHANTOZYGA) GRACILIS KNIGHT, N. SP.

Plate 5, figure 5

Number of whorls	9[a]
Height	4.2 mm.[a]
Greatest width	1.69 mm.
Apical angle, over all	28½°
Apical angle, neanic	30°
Pleural angle	22°
Ratio of height to width	2.5
Ratio of height of body whorl to tota	.51
Number of costae, fourth whorl	20
Number of costae, eighth whorl	35

[a]The only specimen may not be quite mature.

High-spired; sides straight; whorl profile rounded; sutures rather deep; whorls over half as high as wide; aperture sub-oval; base rounded.

Transverse costae slightly wider than the revolving lirae, low, rounded, of even height, not so wide as their interspaces. They show no sinuosity but have reversed obliquity. They pass from the upper suture entirely across the whorl face and the base to the columellar lip. The revolving lirae are quite strong, not so wide as the transverse ribs, and somewhat sharper. Their interspaces have a little more width than the lirae themselves. The lirae are equally well developed on the whorl face and on the base. They number about twenty on the final whorl, while about ten may be counted between sutures on the next whorl above. No traces of coloration are to be seen.

The nucleus of the only specimen in my collection seems on first glance to be smooth, but a careful examination discloses evidence that it was originally costate and that its apparent smooth condition is due to abrasion or corrosion of which there are also some signs on the neanic whorls. Inasmuch as *H. gracilis* is the only named species at present referable to the subgenus, comparisons are hardly necessary and yet "*Aclisina*" *? costata* Mark and "*Aclisina*" *? ornata* Mark may be found to belong to *Hyphantozyga* rather than *Plocezyga* where they are both tentatively assigned. In any case these forms may be distinguished by the fact that, among other seeming differences, their transverse costae are much stronger and more widely spaced.

Top of the Labette shale, Locality 43, one specimen. Holotype, Yale Peabody Museum, No. 13003.

HEMIZYGA (HYPHANTOZYGA) SP.
Plate 5, figure 6

This minute specimen, scarcely more than a millimeter in height and with only two and one-half post-nuclear volutions is no doubt the young of some undescribed member of the subgenus. It would be dangerous to attempt to characterize the adult from it and therefore useless to distinguish it by a specific name. Nevertheless it is figured for the light it throws on the concept of the genus.

The specimen cannot be considered the young of *H. gracilis* as it not only has a considerably greater apical angle than the neanic whorls of that species but both its transverse and revolving lirae are very much finer and more numerous.

This specimen was collected from the top of the Labette shale at Locality 43. Specimen, Yale Peabody Museum, No. 13004.

GENUS CYCLOZYGA KNIGHT, N. G.

CYCLOZYGA MIRABILIS KNIGHT, N. SP.
Plate 5, figure 7

Number of whorls	8
Height	2.5 mm.
Greatest width	1.5 mm.
Apical angle, over all	48½°
Apical angle, neanic	60°
Pleural angle	32½°
Ratio of height to width	1.68
Ratio of height of body whorl to total	.58

Turbinate; sides straight; whorl profile sharply rounded; sutures deep; whorls about 40 per cent as high as wide; aperture sub-circular; base rounded; outer lip without sinuosity, slanting obliquely backward from the upper suture.

Four rather sharp but low revolving ridges with wide concave interspaces are present on the whorl faces. The interspaces are approximately equal to one another in width but the space between the upper suture and the uppermost ridge is a little broader than the interspaces themselves. The base is smooth. The very obscure lines of growth which constitute the only transverse ornamentation, pass obliquely downward and backward from the upper suture without any trace of a sinus.

The relatively low *Trochonema*-like ridges of this species serve at once to distinguish it from *C. carinata* the only other known species of this genus.

I have 32 specimens of this species from the top of the Labette shale at Locality 43; 20 from Zone G, 8 from Zone R, and 4 unallocated. Holotype, Yale Peabody Museum, No. 13005.

CYCLOZYGA CARINATA KNIGHT, N. SP.
Plate 5, figure 8

Number of whorls	9[ab]
Height	4.3 mm.[a]
Greatest width	2.2 mm.
Apical angle, over all	40°[a]
Apical angle, neanic	40°
Pleural angle	40°
Ratio of height to width	2.0[a]
Ratio of height of body whorl to total	.51[a]

[a]Estimated on the assumption that 2 apical whorls are missing.

[b]The holotype and largest specimen from which these measurements were taken shows evidence of having lost at least one more adult whorl for which no allowance has been made in these estimates.

Moderately high-spired and turreted; sides straight; whorl profile rounded to sub-angular; sutures deep; base somewhat flattened; aperture sub-quadrate.

The ornamentation consists of two elements, revolving carinae and transverse lirae, the former of which is dominant. The revolving carinae number four prominent ones on the whorl face and about eight finer ones on the base. Of the four carinae on the whorl face, the second below the upper suture is the most prominent and forms the slight angulation of the whorl profile. The other three are less prominent and sub-equal although more prominent than those on the base. The distance between the upper suture and the uppermost lateral carina is about half again as wide as the interspaces between the carinae, while the lowermost passes only a little above the lower suture. The transverse lirae, more prominent on the earlier whorls than on the later ones, are fine, sharp and rather regularly spaced. Although very much finer and more numerous than the revolving carinae their sharpness and regular spacing gives them a conspicuity their relative size does not warrant. Their course is obliquely backward and downward without sinuosity. The nucleus of the holotype is colorless while post-nuclear whorls are a dark gray. It is suggested that this may approximate the colors of life.

C. carinata is differentiated from *C. mirabilis* by a relatively higher spire, sharp revolving carinae instead of low ridges, sharp, fine transverse lirae in place of simple lines of growth, and larger size.

Top of the Labette shale (Zone G) at Locality 43, four specimens. Holotype, Yale Peabody Museum, No. 13006.

REGISTER OF LOCALITIES

LOCALITY 6 "Davis Place" sub-division of Clayton, St. Louis County, Missouri. The exposure was about 200 feet north of Clayton road on the first street west of Kirkwood-Ferguson trolley tracks and consisted of residual blocks of the lower two feet of the Pawnee limestone in place on Labette shale. It was the result of sub-division grading and is no longer exposed.

LOCALITY 10 Southeast corner of Wydown boulevard and Glenridge Avenue, Clayton, St. Louis County, Missouri. Exposure of lower Fort Scott limestone in place and weathered material of the same beds thrown out on surface from excavations. The result of sub-division work and no longer exposed.

LOCALITY 42 Exposure of lower Fort Scott limestone in steep embankment back of new buildings on Pershing Avenue at Cleveland Walk, University City, St. Louis County, Missouri. The result of sub-division grading and no longer exposed.

LOCALITY 43 Exposures along one of the headwater branches of Feefee Creek six-tenths mile west of Lackland station of the C. R. I. & P. railroad and one mile northwest of Stratmann, St. Louis County, Missouri. The section exposed at intervals for about one-half mile along this creek ranges from the shales below the Summit (?) coal horizon up through about 20 feet of the topmost massive sandstone of the section in the Pleasanton formation. Many of the shale beds within this range are exposed as are all the limestones except the upper Fort Scott. The new belt boulevard extension of Denny road has recently been put through this hollow and this excellent section will probably be available for many years to come.

LITERATURE

1 Literature containing descriptions and–or figures of North American Pennsylvanian Pseudozygopleurinae.

a. Cox, 1857. Geol. Survey Kentucky, Vol. 3.
b. Girty, 1915. U. S. Geol. Survey, Bull. 544.
c. Girty, 1915. Missouri Bureau Geol. & Mines, Ser. 2, Vol. 13.
d. Herrick, 1887. Denison Univ. Bull., Vol. 2, parts 1 & 2.
e. Mark, 1912. Geol. Survey Ohio, 4th ser., Bull. 17.
f. Meek, 1871. Acad. Nat. Sci. Phila., Proc., 1871.
g. Meek and Worthen, 1860. Acad. Nat. Sci. Phila., Proc., 1860.
h. Meek and Worthen, 1866. Geol. Survey Illinois, Vol. 2.
i. Meek and Worthen, 1873. Geol. Survey Illinois, Vol. 5.
j. Morningstar, 1922. Geol. Survey Ohio, 4th Ser., Bull. 25.
k. Plummer and Moore, 1921, Univ. of Texas, Bull. 2132.
l. Stevens, 1858. Amer. Jour. Sci., (2), Vol. 25.
m. White, 1881, U. S. Geog. Sur. W. 100th Merid., Vol. 3, Supp. Appendix.
n. Whitfield, 1882. New York Acad. Sci., Annals, Vol. 2.
o. Whitfield, 1891. New York Acad. Sci., Annals, Vol. 5.
p. Whitfield, 1895. Geol. Survey Ohio, Vol. 7.
q. Worthen, 1884. Illinois State Mus. Nat. Hist., Bull. 2.
r. Worthen, 1890. Geol. Survey Illinois, Vol. 8.

2. a. Donald, J., Observations on the genus *Aclisina*, etc., Quart. Jour. Geol. Soc., London, Vol. 54, pp. 45-72, pls. 1898.
b. Longstaff, J., (née Donald) Supplementary notes on *Aclisina*, etc., Quart. Jour. Geol. Soc., London, Vol. 73, pp. 59-82, pls. 1917.

3. a. Koken, E., Die Fauna der Raibler Schichten vom Schernplateau. Deutschen geolog. Gesell. Zeitschrift, XLIV, 1892.
b. Koken, E., Ueber die Gastropoden der rothen Schlernschichten, etc., Neues Jahrb. f. Mineralogie, Geologie u. Paleontologie, II, Band, 1892.
4. Longstaff, J., (née Donald). On the Genus *Loxonema*, etc., Quart. Jour. Geol. Soc., London, Vol. 65, pp. 210-223, pls. 1909.
5. Knight, J. B., Pennsylvanian Outlier at St. Louis, Missouri and its correlations. Abs. Geol. Soc. Am. Bull., Vol. 40, p. 190, 1929.
6. Koken, E., Ueber die Entwickwlung der Gastropoden, etc., Neues Jahrb. f. Minerologie, Geologie u. Paleontologie, VI, Beilage, Band, 1889, pp. 305-484, pls.
7. Girty, G. H., The Guadalupian Fauna. U. S. Geol. Survey, Prof. Paper 58, 1908.
8. Girty, G. H., Fauna of the Wewoka formation of Oklahoma, U. S. Geol. Survey Bull. 544, 1915.
9. Meek, B. F., and Worthen, A. H., Geol. Survey Illinois, Vol. 5.
10. Knight, J. B., Reconsideration of the Pennsylvanian Zygopleuroid gastropods, Geol. Soc. Am. Bull., Vol. 41, p. 201, 1930. (See appendix present paper).
11. Perner, J., in Barrande. Systême Silurian du Centre de la Bohême, Vol. IX, Gastéropodes.
12. a. Zittel, K. A., Text-book of Paleontology, 2nd English edition, edited by C. R. Eastman, 1913.
b. Zittel, K. A., Grundzüge der Paläontologie, 6th German edition, edited by F. Broili, 1924.
13. Clarke, J. M., Naples fauna of western New York, pt. 2, New York St. Mus., Mem. 6.
14. Frech, F., Loses und geschlossenes Gehäuse der tetrabranchiaten Cephalopoden, Centralblatt f. Min., Geol. u. Paläont., 1915, p. 593.
15. Girty, G. H., in the Stratigraphy of the Pennsylvanian Series in Missouri, Hinds and Greene, Chap. VIII, Invertebrate Paleontology. Missouri Bureau Geol. and Mines, Vol. 13, 2nd ser., 1915.
16. Mark, C. G., in Conemaugh formation in Ohio, Condit, Chap. 5, The Fossils of the Conemaugh formation in Ohio, Geol. Survey Ohio, 4th ser., Bull. 17, 1912.
17. Weller, J. M., Cyclical sedimentation of the Pennsylvanian Period and its significance, Jour. Geol., Vol. 38, pp. 97-135.
18. a. Dall, and Bartsch, P., A monograph of west American pyramidellid molluscs. U. S. Nat. Mus., Bull. 68, 1909.
b. Bartsch, P., Additions to the west American pyramidellid mollusk fauna, with descriptions of new species. U. S. Nat. Mus., Proc., Vol. 42, pp. 261-290, and A zoogeographic study based on the pyramidellid mollusks of the west coast of America, the same pp. 297-344.
19. Grueneberg, H., Vererbungswissenschaftliche Studien Über einige Murchisonien des Oberen Mitteldevons, Deutsch. Geol. Ges. Zeitschr. lxxix, Abh. pp. 385-404.
20. McCoy, F., A Synopsis of the Characters of the Carboniferous limestone fossils of Ireland, 1862.
21. Savage, T. E., Marine invertebrate fossils as horizon markers in the Pennsylvanian rocks of Illinois. Jour. Geol., Vol. 32, p. 581, 1924.

APPENDIX

The abstract of this paper was omitted through editorial oversight when volume 41 of the Bulletin of the Geological Society of America was made up. However it was published in the "Preliminary List of Titles and Abstracts"

and distributed to the entire membership of the Geological Society and affiliated societies and to all those who attended the Forty-second Annual Meeting at Washington, D. C., in December, 1929. Thus it has had rather wide distribution, although, as few preserve these "Preliminary lists," a copy might now be difficult to obtain. Hence as the abstract contained the original publication of the generic name *Pseudozygopleura* with the designation of the genotype, it is thought that it may be of service to future workers to give a verbatim quotation of it here.

The following is an exact copy of the above mentioned abstract as printed on page 54 of the Preliminary List of Titles and Abstracts of Papers to be offered at the Forty-second Annual Meeting of the Geological Society of America at Washington, D. C., December 26-28, 1929.

A RECONSIDERATION OF THE PENNSYLVANIAN ZYGOPLEUROID GASTROPODS

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(*Abstract*)

Generic criteria for gastropods, such as form, ornamentation, apertural and nuclear characteristics are briefly discussed. It is emphasized that Koken's genus *Zygopleura* has a smooth, unornamented nucleus. The Pennsylvanian forms heretofore referred to that genus have, on the other hand, sculptured nuclei that are highly characteristic. The conclusion is drawn that these Pennsylvanian (and probably all pre-Triassic) forms are homeomorphs of *Zygopleura* and are improperly referred to that genus. Furthermore, it is shown that this characteristically ornamented nucleus is to be found not only on forms with typical zygopleuroid costae, but also on forms partially or wholly without sculpture, with revolving lirae only or with combinations of these types of ornamentation, and that these forms sometimes quite different in their adult expression, are nevertheless quite closely related. A new genus, *Pseudozygopleura*, divided into a number of subgenera, is proposed to accommodate these forms and the genus and subgenus are defined and illustrated. *Loxonema semicostata* Meek is chosen as the genotype.

A brief discussion of the derivation and taxonomic position of *Zygopleura* and *Pseudozygopleura* is presented. Lack of knowledge of the ontogeny of pre-Carboniferous forms is a barrier to any definite conclusion.

PLATE 1

PLATE 1

EXPLANATION OF PLATE 1

FIGS. 1a-e—*Pseudozygopleura* (*Pseudozygopleura*) *semicostata* (Meek). a, The holotype, after Meek, × 6½. b, The cyrioplesiotype, × 6. c, A plesiotype with obscure costae on only the first two post-nepionic whorls, × 6. d, A plesiotype with no trace of post-nepionic costae, × 6. e, A plesiotype, × 6. It is interesting to compare this figure with Worthen's figure of *P. peoriensis* (Worthen), a larger but similar form.

2a-c—*Pseudozygopleura* (*Pseudozygopleura*) *scitula* (Meek and Worthen). a, A plesiotype from the top of the Labette shale, × 2. b, The cyrioplesiotype, × 2. c, A plesiotype from the lower Fort Scott limestone, × 2.

3—*Pseudozygopleura* (*Pseudozygopleura*) *croneisi* Knight, n. sp. The holotype, × 6.

4—*Pseudozygopleura* (*Pseudozygopleura*) sp. A, The only specimen, × 4.

5a-c—*Pseudozygopleura* (*Pseudozygopleura*) *williamsi* Knight, n. sp. a, The holotype, from the top of the Labette shale, × 6. b, A paratype from the Pawnee limestone, × 6. c, A paratype from the top of the Labette shale, × 4.

6a-b—*Pseudozygopleura* (*Pseudozygopleura*) *girtyi* Knight, n. sp. a, The holotype, from the Labette shale, × 4. b, A paratype, from the Pawnee limestone, × 4.

7—*Pseudozygopleura* (*Pseudozygopleura*) *trochus* Knight, n. sp. The holotype, × 4.

8—*Pseudozygopleura* (*Pseudozygopleura*) *rothi* Knight, n. sp. The holotype, × 8.

9—*Pseudozygopleura* (*Pseudozygopleura*) *condrai* Knight, n. sp. The holotype, × 4.

10a-b—*Pseudozygopleura* (*Pseudozygopleura*) *plummeri* Knight, n. sp. a The holotype, × 4. b, A paratype, × 4.

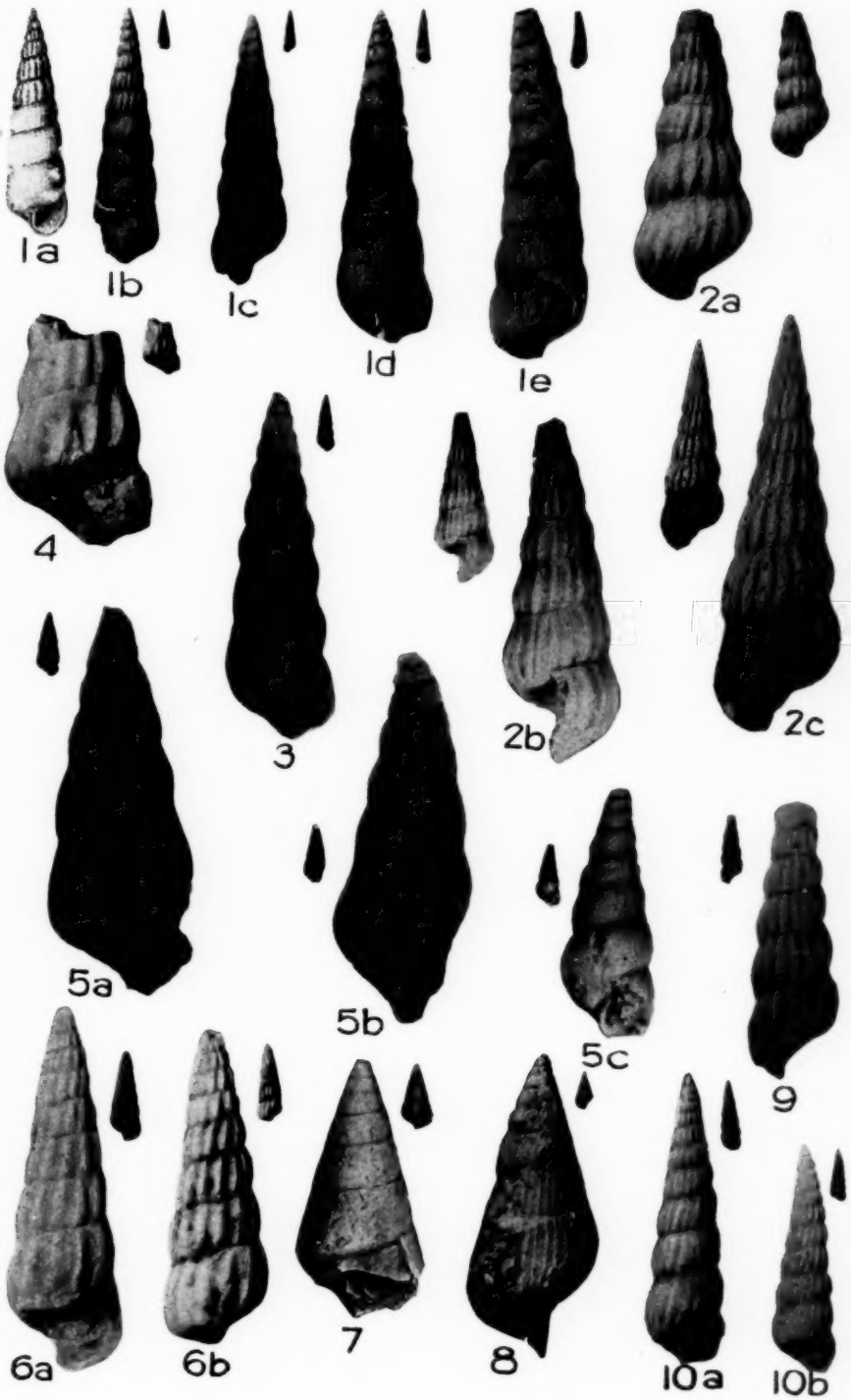

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PLATE 2

PLATE 2

EXPLANATION OF PLATE 2

FIGS 1a-b—*Pseudozygopleura* (*Pseudozygopleura*) *conica* Knight, n. sp. a, A paratype, × 8. b, The holotype, × 8.

2—*Pseudozygopleura* (*Pseudozygopleura*) *werneri* Knight, n. sp. The holotype, × 4.

3—*Pseudozygopleura* (*Pseudozygopleura*) *sinuosior* Knight, n. sp. The holotype, × 6.

4—*Pseudozygopleura* (*Pseudozygopleura*) *pulchra* Knight, n. sp. The holotype, × 10.

5—*Pseudozygopleura* (*Pseudozygopleura*) *terebra* Knight, n. sp. The holotype, × 10.

6—*Pseudozygopleura* (*Pseudozygopleura*) *pagoda* Knight, n. sp. The holotype, × 8.

7—*Pseudozygopleura* (*Pseudozygopleura*) *restis* Knight, n. sp. The holotype, × 8.

8—*Pseudozygopleura* (*Pseudozygopleura*) *schucherti* Knight, n. sp. The holotype, × 4.

9—*Pseudozygopleura* (*Pseudozygopleura*) *moorei* Knight, n. sp. The holotype, × 4.

10—*Pseudozygopleura* (*Pseudozygopleura*) *deloi* Knight, n. sp. The holotype, × 4.

11—*Pseudozygopleura* (*Pseudozygopleura*) *pluricostata* Knight, n. sp. The holotype, × 4.

12a-b—*Pseudozygopleura* (*Pseudozygopleura*) *perversa* Knight, n. sp. a, holotype, × 6. b, A paratype, an immature individual, × 10.

13—*Pseudozygopleura* (*Pseudozygopleura*) *pupa* Knight, n. sp. The holotype, × 6.

14a-b—*Pseudozygopleura* (*Pseudozygopleura*) *nigra* Knight, n. sp. a The holotype photographed so as to show the uniform black coloration, × 6. b, The holotype with a coating of ammonium chloride, × 6.

15a-b—*Pseudozygopleura* (*Pseudozygopleura*) *kellettae* Knight, n. sp. a, The holotype, × 8. b, A paratype, × 8.

16—*Pseudozygopleura* (*Pseudozygopleura*) *recticostata* Knight, n. sp. The holotype, × 6.

17—*Pseudozygopleura* (*Pseudozygopleura*) *obtusicacuminis* Knight, n. sp. The holotype, × 4.

18a-b—*Pseudozygopleura* (*Pseudozygopleura*) *tenuivirga* Knight, n. sp. a, A paratype photographed so as to show the characteristic narrow color band, × 8. b, The holotype, coated with ammonium chloride, × 8.

19—*Pseudozygopleura* (*Pseudozygopleura*) *inornata* Knight, n. sp. The holotype, × 6.

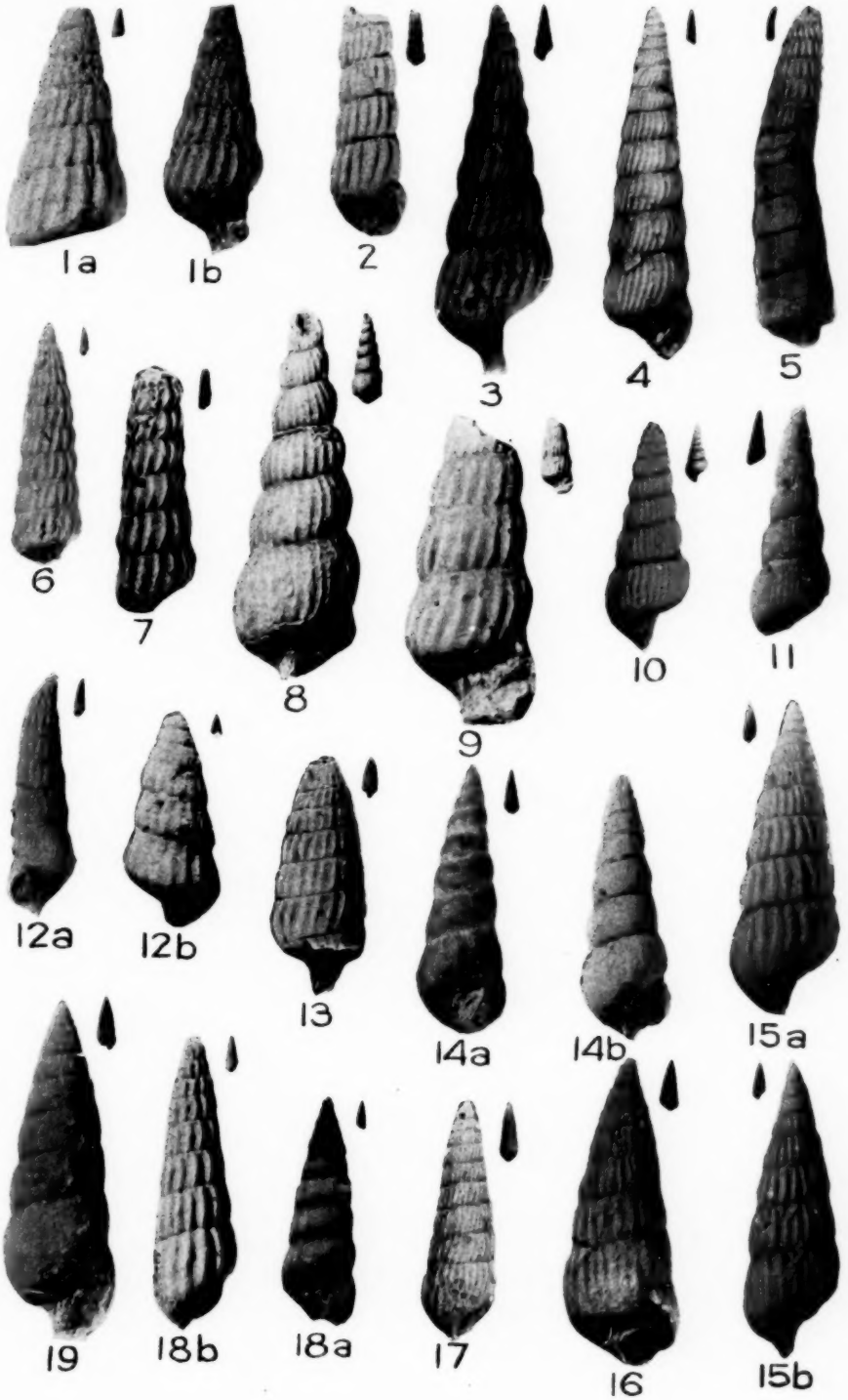

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PLATE 3

PLATE 3

EXPLANATION OF PLATE 3

FIGS. 1a-b—*Pseudozygopleura* (*Pseudozygopleura*) *assertonsoris* Knight, n sp. a, The holotype, coated with ammonium chloride, × 10. b, The same specimen photographed to show the broad revolving color banding, × 10.

2a-b—*Pseudozygopleura* (*Pseudozygopleura*) *leveneae* Knight, n. sp. a, The holotype, photographed to show dark coloration of the final whorl, × 8. b, The same, coated with ammonium chloride so as to bring out the sculpture, × 8.

3—*Pseudozygopleura* (*Pseudozygopleura*) *acuminata* Knight, n. sp. The holotype, × 4.

4—*Pseudozygopleura* (*Pseudozygopleura*) *praecuta* Knight, n. sp. The holotype, × 6.

5—*Pseudozygopleura* (*Pyrgozyga*) *warthini* Knight, n. sp. The holotype, × 6.

6a-b—*Pseudozygopleura* (*Pyrgozyga*) *cylindrata* Knight, n. sp. a, A paratype photographed so as to show the characteristic color banding, × 4. b, The holotype, × 4.

7a-d—*Pseudozygopleura* (*Pyrgozyga*) *macra* Knight, n. sp. a, The holotype, × 6. b, A paratype, × 6. c, A paratype, × 6. d, A paratype photographed to show the color banding, × 8.

8a-b—*Pseudozygopleura* (*Pyrgozyga*) *dunbari* Knight, n. sp. a, The holotype, × 6. b, A paratype, a young individual showing the characters of the neanic whorls, × 4.

9a-b—*Pseudozygopleura* (*Pyrgozyga*) *marvinwelleri* Knight, n. sp. a, The holotype, × 4. b, A paratype, × 4.

10—*Pseudozygopleura* (*Pyrgozyga*) *funis* Knight, n. sp. The holotype, × 4.

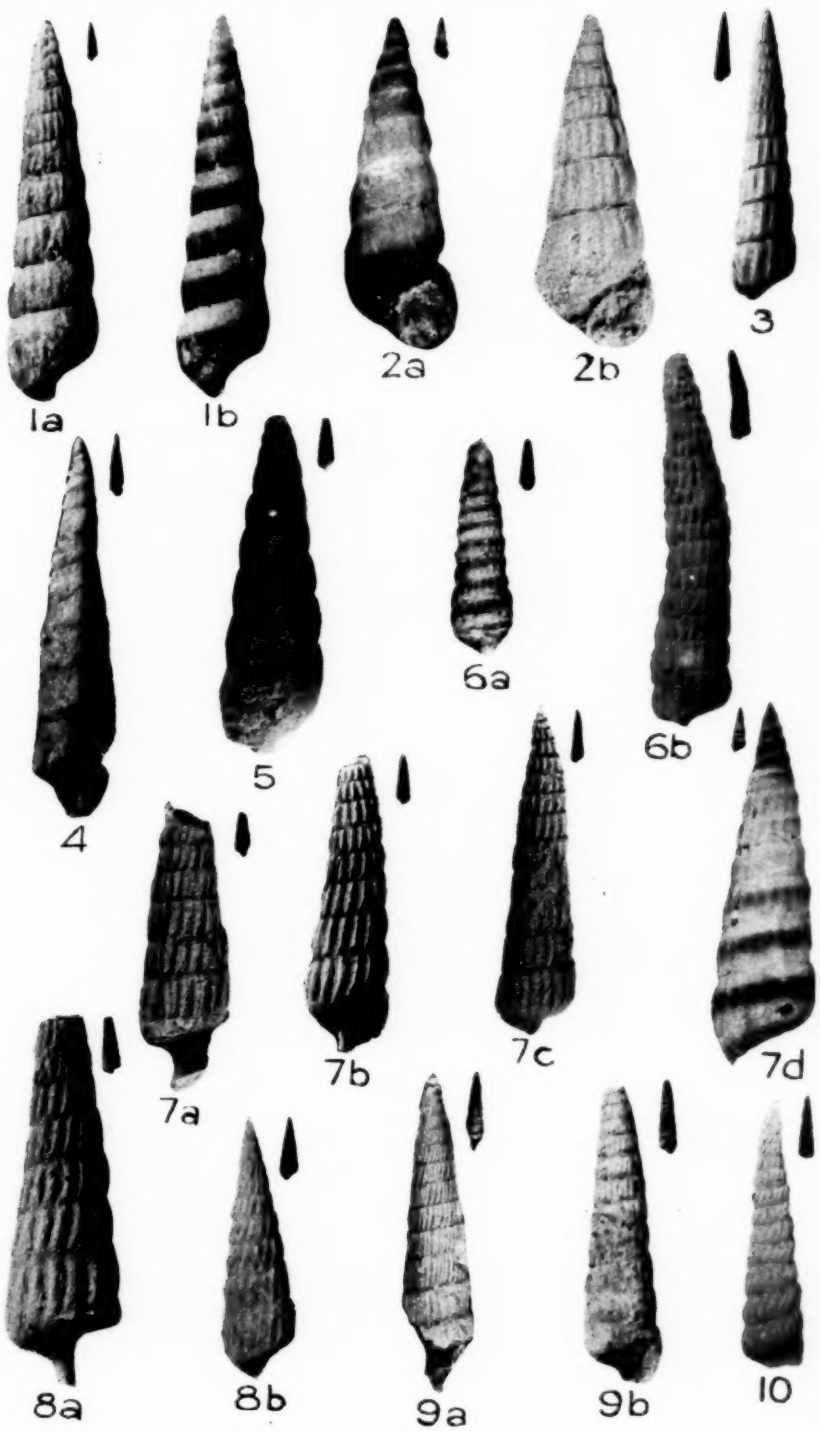

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PLATE 4

PLATE 4

EXPLANATION OF PLATE 4

FIGS. 1—*Pseudozygopleura* (*Stephanozyga*) *subnodosa* Knight, n. sp. The holotype, × 2.

2—*Pseudozygopleura* (*Leptozyga*) *minuta* Knight, n. sp. The holotype, × 20.

3a-d—*Helminthozyga vermiculus* Knight, n. sp. a, A paratype that continued coiled further than any other specimen in the collection; its base is widely umbilicate, × 20. b, The holotype showing uncoiling after the second neanic whorl, × 20. c, A paratype, being a fragment of the uncoiled portion of a large specimen, × 10. d, A paratype; the uncoiling on this specimen began after the first neanic whorl, × 20.

4—*Hemizyga* (*Plocezyga*) *corona* Knight, n. sp. The holotype, × 8.

5a-b—*Hemizyga* (*Plocezyga*) *tenuilirata* Knight, n. sp. a, The holotype, × 4. b, The paratype, × 6.

6—*Hemizyga* (*Plocezyga*) *percostata* Knight, n. sp. The holotype, × 8.

7—*Hemizyga* (*Plocezyga*) *abolescens* Knight, n. sp. The holotype, × 8.

8a-b—*Hemizyga* (*Plocezyga*) *angularis* Knight, n. sp. a, The holotype, × 8. b, A paratype, × 6.

9—*Hemizyga* (*Plocezyga*) *tenuis* Knight, n. sp. The holotype, × 8.

10—*Hemizyga* (*Hemizyga*) *corbis* Knight, n. sp. A paratype, an immature individual, × 8.

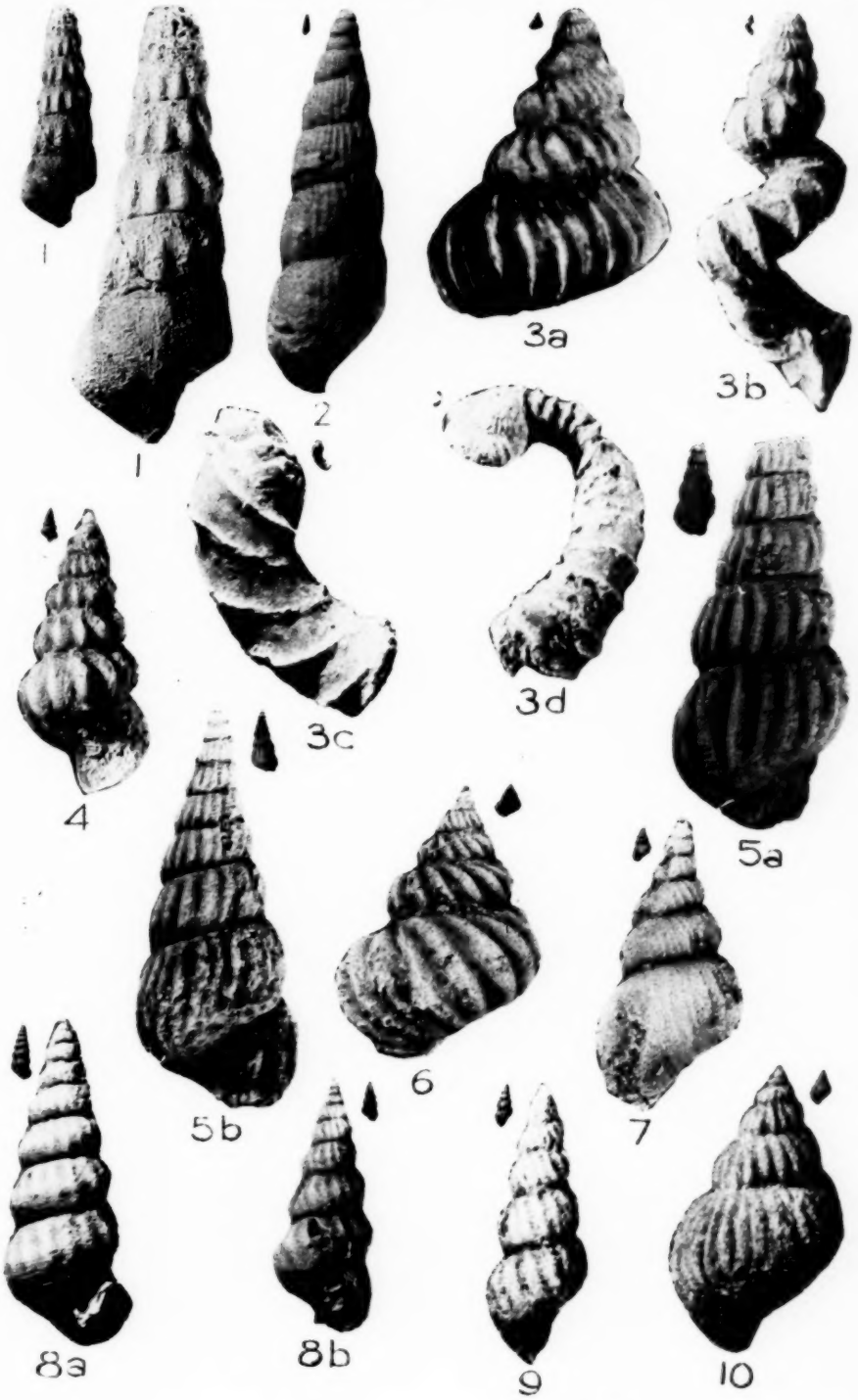

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PLATE 5

PLATE 5

EXPLANATION OF PLATE 5

FIGS. 1—*Hemizyga* (*Hemizyga*) *inflata* Knight, n. sp. The holotype, × 6.

2a-b—*Hemizyga* (*Hemizyga*) *illineata* Knight, n. sp. a, The holotype, apertural view, × 2. b, The same, dorsal view, × 2.

3—*Hemizyga* (*Hemizyga*) *corbis* Knight, n. sp. The holotype, × 4.

4—*Hemizyga* (*Hemizyga*) *corpulentissima* Knight, n. sp. The holotype, × 4.

5—*Hemizyga* (*Hyphantozyga*) *gracilis* Knight, n. sp. The holotype, × 8.

6—*Hemizyga* (*Hyphantozyga*) sp. An immature individual, × 30.

7—*Cyclozyga mirabilis* Knight, n. sp. The holotype, × 15.

8—*Cyclozyga carinata* Knight, n. sp. The holotype, × 10.

9—Reproduction of Koken's figure illustrating the smooth unornamented nucleus of *Zygopleura hybrida* Münster.

10—Photograph of the lip of a specimen of *Zygopleura arctecosta* (Münster), a Triassic species. Note that the nuclear whorls are smooth and unornamented. × 8.

11—A photograph of a Pennsylvanian zygopleuroid, *Pseudozygopleura* (*Pseudozygopleura*) sp. undet. Note the highly sinuate costae on the third whorl. Similar costae are present on the second nuclear whorl though they do not show as well. The phylembryonic first whorl or protoconch is unornamented. The neanic and ephebic whorls of this specimen carry weakly sinuate costae quite comparable with those of Zygopleurae at the same stages of growth. The specimen has been whitened with ammonium chloride to bring out the sculpture. × 6½.

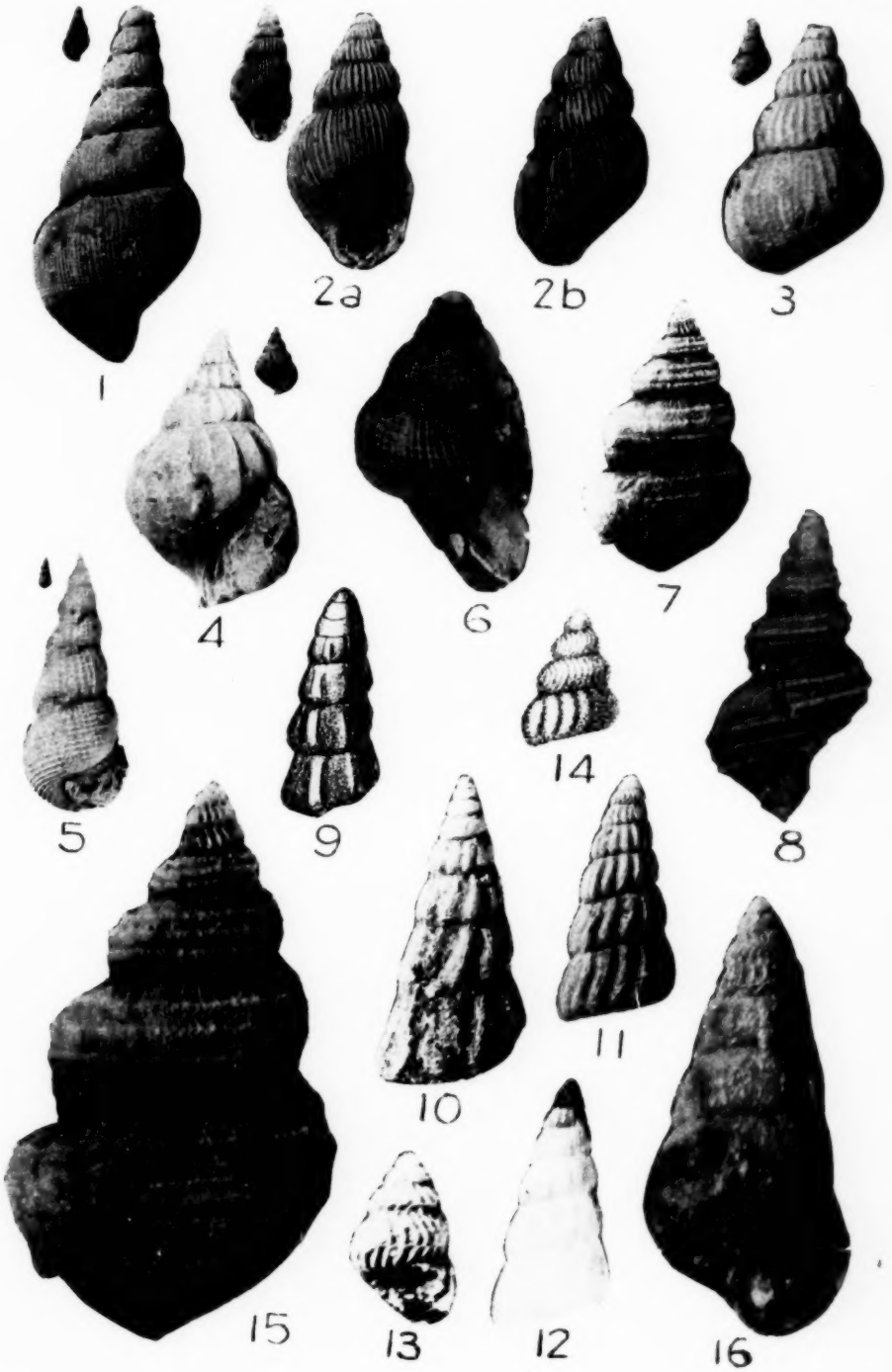
12—The same specimen as that shown as figure 11, but without the ammonium chloride. This photograph shows the pigmented black nuclear whorls of this species in strong contrast with the (in this species) colorless neanic whorls. A similar darkened nucleus is found on many (but not all) other species. × 6½.

13—A nepionic shell of an undetermined species of one of the Pseudozygopleurinae. Note the strong sinuosity of the nuclear costae and their peculiar and characteristic course. × 40.

14—Reproduction of Meek and Worthen's figure of the nucleus of *Pseudozygopleura* (*ss*) *semicostata* (Meek). They noted the presence of costae on the nucleus but manifestly failed to note or to reproduce the peculiar and characteristic sinuosity of the costae. The first three whorls of their figure are nuclear; the fourth is neanic.

15—The holotype of *Cyclozyga mirabilis* Knight magnified 30 diameters to show the nucleus characteristic of the Pseudozygopleurinae on a shell with only revolving ridges at post-nuclear stages.

16—A young specimen of an undetermined species of *Pseudozygopleura* (*ss*) magnified 30 diameters to show the typical nucleus on a shell entirely without ornamentation at post-nuclear stages. Meek and Worthen figure rather crudely a somewhat similar shell (Ill. Geol. Survey, Vol. 5, pl. 29, figs. 4a and 4b).



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